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Engineering News-Record

Lining of the Hudson River Vehicle Tunnel

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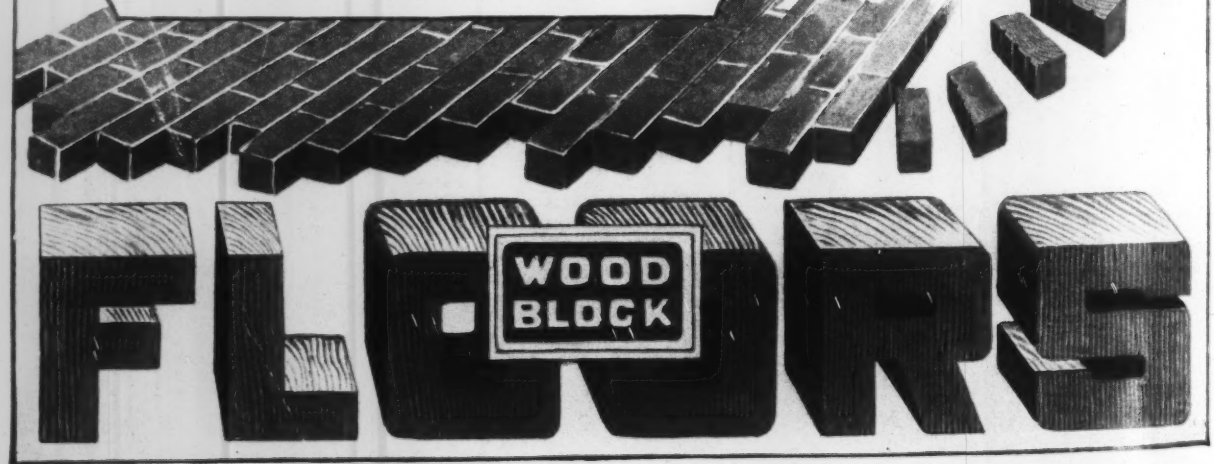

A Consolidation of Engineering News, Engineering Record and The Contractor

ENGINEERING NEWS-RECORD

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FRANK C. WIGHT
Editor

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Against Public Interest

THE fundamental principle in the proper control of utilities is that the public has a major interest in their administration. This has long since been applied to the income of the utility through its rates but it has had only recent application to its outgo through the expenses of labor. It was this public interest in the wages labor receives that marked most distinctively the Railway Labor Board, for on that board labor, management and the public are equally represented and no action can be taken without at least one of the public's representatives concurring. Whatever criticism there be of the usefulness of that board, it cannot be denied that the public representation feature has been most salutary and should be continued in any revision of the Transportation Act. The Barkley-Howell bill, now before Congress, does away with that feature and substitutes for the three-party board a series of sectional bodies representative on the one hand of the railways and on the other of the national unions, with voluntary but not compulsory appeal on their part to a possibly unbiased mediation board. There are a number of things wrong with the Barkley-Howell bill, but this one is enough to condemn it. The time is past when labor and management of a public utility should be allowed to get together and make any arrangement they please as to wages, which in the end the public must pay.

Canada Speaks Out

CANADA'S official attitude on the diversion of water through the Chicago River, as stated in the diplomatic correspondence noted in this week's news pages, is an interesting example of how skilled politicians can soothe domestic clamor by judicious condemnation of foreign iniquity. The Dominion is no more united than is this country on the question of the proper development of the St. Lawrence. Port Arthur, like Duluth, dreams large dreams of ocean liners drawn up to its wharfs, but Montreal, like New York, wakes cold and clammy at night at the vision of becoming a mere stopover on the way to the fertile West. Ontario and New England alike want cheaper power, and care little what kind of ships go West or come East. Washington and Ottawa have the same problem of composing the sectional differences that have arisen. It is the easiest way out just now for the Canadian national administration to avoid the direct issues of the St. Lawrence problem and to concentrate its attack on Chicago, who has no friends in either Saskatchewan or Quebec. Nevertheless, Chicago may well read the writing on the wall. The Great Lakes are international and the Congress at Washington cannot but consider the complications of their control. To pass a law authorizing a diversion not yet approved by our highest court, and in defiance of the expressed attitude of the joint owner of these waters, would be in flagrant disregard of both national policy and international comity.

Shield Tunneling Advance

WITH the largest bore of any of the twenty-two shield-driven under-river tunnels giving access to Manhattan Island, the New York vehicular tunnel is making a noteworthy record of progress. Over half of the tunneling proper has been completed; there have been few interruptions of work, and there has been an astonishing freedom from accidents to structure or to workers. A remarkable fact is the entire absence of fatality from compressed air illness. Indeed the record of operations as outlined elsewhere in this issue would be uneventful except for the deflection from grade at times of shield and lining, an occurrence remedied by weighing down the tunnel shell and increasing the volume of material taken into the shield. The facts related carry an important thought. It is largely from the increased finesse of shield tunneling that these favorable results come. In the broader processes of soft-ground tunneling, with shield and cast-iron lining, there have been few radical alterations in many years, but there has been a remarkable advance in perfection of detail and surety of procedure. Perhaps nowhere in the world has this perfection of skill and contrivance been developed so highly as among the engineers, contractors and trained tunnel workers of New York City. And nowhere in the world, of course, have there been in the last scoe of years so great a mileage or so many subaqueous tunneling operations. The successful results of the vehicular tunnel work are the product of this experience.

Motor Vehicle Accidents

IMPRESSIVE in number as are the Connecticut motor-vehicle accidents analyzed in this issue, they do not go far toward helping the highway designer to evaluate the danger factors in his problem. As they stand they are actuarial and not engineering data. While the analysis shows when accidents are most frequent, what persons are most frequently the cause and what other persons are most often the victims, it does not, except in the matter of vehicle defects, give us light on the physical causes, either principal or contributory, of road accidents. The figures do not give the accident frequency at intersections, on curves or at railway grade crossings, or indicate the casuality risk of these physical features. They give nothing concerning the effect of slipperiness, narrow pavement or soft and unkept shoulders. There is nothing about collisions with bridges and these are accidents of great significance to highway engineers. In effect the highway engineer as a designer finds little in all the data given which indicates means of designing or building safer road structure. On the contrary as director of transport, so far a very restricted function, he can draw from the Connecticut figures real inspiration for directed effort in regulating highway use. They are notable if they shock the public into realizing the terrible seriousness of motor accidents.

An American Alumina Cement

AFTER some nine months of experimentation, which involved a thorough study of manufacturing processes as well as such physical tests as were possible in that period, an allied company of the Atlas Portland Cement Co. has put on the market an American alumina cement. Ever since the War there has been growing interest in this quick-setting high strength hydraulic cement, which proved so effective in the emergency work at the battle front and which the French seem to be demanding faster than the manufacturers can supply. Up to now, however, American engineers could learn about it only through reports of tests on the French product—which was hardly obtainable in this country—and through some limited tests on some similar cements manufactured in test quantities only by the Bureau of Standards here.

These reports show the material to have remarkable possibilities for some special types of work. Concrete made from it, for instance, in the ordinary proportions gives test strengths in 24 hours equal to or greater than that of portland cement concrete in 28 days. It is not a flash cement; for the first few hours its process of setting is quite comparable to portland but sometime between four and twelve hours its strength shoots straight up. For emergency work, such as street repairs, rail crossovers, oil well linings, concrete floor finish, grouting, etc., this is a tremendous advantage and the possibilities of use in concrete piles or even in bridges and buildings where form re-use is important are obvious. Then, too, claims for a superior resistance to saline attack were made for this alumina cement, and although these claims are not as readily proved or as easily studied as those regarding strength and setting speed, they draw attention to the new cement as a desirable material.

All of these claims, however, American engineers have hitherto had to take mainly on faith, for as has been said, the French product was practically unobtainable. Now anyone who wishes can test out the cement for himself. The manufacturer is continuing his own tests, which will be made public when they have acquired sufficient body, but he is enough impressed with them to undertake commercial production of the cement. Many engineers will want to take advantage of this opportunity to test out for themselves the utility of the new product. The cost of the new cement is above twice as much—bulk for bulk—as for ordinary portland, and except for its early high strength, the possibly higher resistance to salts, and a darker color, it has the same qualities as a portland. Indeed, but for a slighter higher insoluble residue, the new American alumina cement will pass the standard portland specification. Its great utility is in the early high strength and that is a most important desirable quality, when taken along with the usual qualities that portland cement possesses.

There is no danger that alumina cement will supersede portland—whatever its qualities—because for its manufacture it requires a high alumina ore, like bauxite, which is of rare and concentrated occurrence. The price must therefore probably always be high—too high perhaps to compete with the readily made portland. But the peculiar advantages of the alumina cement make it a most interesting possibility which the American engineers will be quick to investigate and explore.

Broader Transit Planning

NEW views are introduced into the much debated and always perplexing subject of rapid transit in the report on the New York suburban passenger problem reviewed on p. 818. They are of such wide influence as to open up a new perspective in the treatment of city transportation matters. The significance of the report lies in its general as well as its local bearings. The former naturally are of broader interest, but the character of the discussion and conclusions rests on the peculiar nature of the local problem which gave rise to it.

Something over a hundred thousand people, living a short distance outside of New York but engaged in business in the city, spend three hours per day in traveling between home and working place. Probably half of this travel time is a dead loss, and at least a third of it should be saved. This reclaimable part represents a very large value, not easily appraised but amounting on the most reasonable basis of estimate at hand to at least $20,000,000 per year, which in turn represents a capital sum approaching half a billion, How to save these lost values has long been one of the major problems of the New York metropolitan district. It is so difficult a problem, however, that it has been largely ignored. Even the present report takes it up chiefly because of the interference with the city's internal transit produced by the tide of inbound and outbound commuters in using the city transit lines for the terminal part of their journey. Nevertheless it is greatly to the credit of Mr. Turner and his co-workers that they overcame longstanding inertia to the extent of perceiving its importance and seeking a solution without regard to tradition.

As the situation suggests, the report is essentially iconoclastic, and in this fact lies its special value. Rapid-transit thinking has been controlled by certain arbitrary views, among them that rapid transit is an intramural matter, that its financial possibility rests on operating profits, and that its great cost burden must be handed down to posterity by means of long-time bond issues. These views have had a serious limiting influence on transit development. The present report disregards them entirely, and in fact asserts directly opposite principles. It makes so strong a case that it is bound to prove of service in clearing the way for transit development wherever needed.

Rapid transit has no necessary relation to political boundaries. Neither its immediate service nor the values it creates are confined to a city area or a congested central district. The present report almost for the first time treats rapid transit as a regional problem. Correspondingly it takes a broad view of its functions. Much past rapid-transit planning and construction seems to have been done to serve the center of the city and to open up new arteries of travel through the congested district. Whether this was the original purpose, or whether high construction costs and limited funds led to the narrow conception, it is certain that only few rapid-transit projects have been worked out for true long-distance service. Some existing rapid-transit lines have done as much to increase congestion as to relieve it. The project outlined in the present report differs from other rapid-transit projects of recent years by dealing wholly with the long-distance phase of transportation and keeping clear of the

congested area. It aims to connect the residential suburbs with the working area of the city, not, however, connecting with the latter area by radial tap lines capable of serving as further arteries of internal circulation but approaching it by a large encircling loop.

At to the second point, financing of rapid transit has always been treated in the same way as financing a railroad, on the basis of capitalized operating revenue. This line of thought had to be abandoned in the present case because the huge volume of costs made it impracticable and because the contemplated system involved extensive benefits to others than the users of the lines. These other benefits, it was found, can pay all or a large part of the cost of the system, and the financial plan was accordingly based on assessing them. A similar idea has been proposed in two prior cases, but with these exceptions the present report is completely at odds with past views and practice. The result of basing all previous planning upon operating revenue is the main reason why many cities that are greatly in need of rapid transit have failed to get it, being unable to prove in advance that the proposed system could pay its way.

The fact of the matter is that the cost of a rapid-transit system is appallingly high in proportion to the revenues, while on the other hand the distributed capital benefits are very great. Rapid-transit planning thus has come to be a great speculative game, on the one hand promising vast profits to property interests and on the other hand appearing very doubtful as to profitable operation. Since this state of affairs will continue to prevail, it is certain that rapid transit development will always face a great financial problem unless, as in the present project, the cost is paid by property and community benefits rather than the rider.

The report makes another startling financial proposal in rejecting long-time bonding. The cost of the system, though very great, is to be repaid in less than a dozen years, by taxation and benefit assessments. In the past, long-time bond issues have invariably been thought the proper means of financing rapid transit, and as a result great debts have been handed down to future generations. Such transit planning naturally eats into the borrowing margin of a community very fast, so that the execution of a comprehensive plan becomes difficult and hazardous. How the burden has been piled up on future generations in the case of New York is particularly instructive, as it is proving constantly more difficult to clear the way for necessary extensions of the initial rapid-transit lines without hampering other public work.

Local interest in the report centers in its treatment of the New Jersey suburban traffic. Until now, New York has systematically ignored the existence of a joint New York-New Jersey traffic problem; even worse, spokesmen for New York have repeatedly asserted that they would do nothing to assist the New Jersey traffic to cross the Hudson because New York has all the traffic of its own that it can take care of. The present report represents a definite break with this medieval view of community problems. It is a new attack on the problem which Haskin undertook to solve in the seventies when he started a tunnel to bring suburban traffic under the Hudson into New York City, and which in part was later dealt with in other ways by the construction of the Hudson & Manhattan tunnel system and the Pennsylvania tunnels and terminal. But it is radically different from these other enterprises in being planned as a community undertaking. It represents a proposal that the public deal with something which for years has been the natural obligation of private enterprise, but which private enterprise conspicuously failed to handle. The half dozen railroad lines reaching the New Jersey side of the Hudson River either could not or would not take steps to meet the need of their many thousands of commuter patrons to be transported from their suburban homes directly into the city. It is this failure of private enterprise and the proposed entrance of the public into a field belonging to the railroads but neglected by them that constitutes one of the most remarkable features of the report.

As a matter of fact, the public interest in the traffic in question far exceeds the interest of the railroads. More than once a railroad president has said with refreshing frankness that his road did not care for this particular traffic and would prefer to be rid of it—though quite willing to haul the associated freight. For many years there has been an obvious lack of that spirit of enterprise and progress which private business must possess in order to provide a costly and elaborate public service. Further, within the past decade or two the problem involved has grown to staggering proportions, involving such discrepancies between cost and revenue that the only hope for its solution was public planning and public construction.

In grappling with this problem, the engineers for the New York authorities have disregarded the state boundary, just as the distribution of business and traffic disregards this boundary. In effect they extend the idea of the city, or the metropolitan community, out to the New Jersey suburban towns and recognize the necessity of planning transit in this westerly quarter as fully as in the north and east quarters, which are within the State of New York. This is a remarkable innovation. The insular habit of thought is ingrained in the New York mental constitution, and to vast numbers the Palisades are a western horizon in more ways than one. But the integral character of the metropolitan area has become clearer and more emphatic with each passing year. With the present report the time has at last been reached when the government of the city gives concrete recognition to this unity by providing for transit extension across the Hudson.

The details of the plan presented in the report may be open to considerable difference of opinion. Whether the plan will produce any material saving of commuting time remains to be determined; unless it can show such time saving, it is bound to lack justification. At first sight, moreover, the New York loop line which forms part of the proposed system takes too little account of the continuing northward movement in Manhattan and gives undue weight to Wall Street requirements. Again the report is unconvincing in the matter of interlacing its three separate suburban systems in one grand suburban delivery and collection loop. However, the details of the project are unimportant at the present stage. If the plan of regional development and community extension of rapid transit into the suburban commuter field finds acceptance, there will be ample time to restudy the details under the joint auspices of the various interests concerned. The present value of the report lies in the general principles which it embodies and in its radical departure from traditional ideas.

Building the Hudson River Vehicle Tunnel

Seven Shafts Formed by Sinking Steel Pneumatic Caissons—Five 29½-ft. Shields Drive Twin Tubes Through Silt and Rock—Work Free From Serious Mishap

CONSTRUCTION of the vehicle tunnel under the Hudson River between New York and Jersey City has reached a stage of progress where methods are established. All the shafts have been sunk and some 57 per cent of the footage of tube shell has been completed. An account of operations now is, therefore, fairly definite; indeed, barring accident or disclosure of unexpected conditions, no alterations are probable in construction outfit or procedure.

Structural Changes Increase Cost—As originally planned (*Engineering News-Record*, Feb. 19, 1920, p. 357) the structure consisted of twin tubes of cast iron having a mean length of 6,881 ft., and of subway and open-cut approaches. The distance between grade points was 9,300 ft.; the outside shell diameter of both tubes was 29 ft., and the estimated cost was $28,669,000. As now planned the location and linear dimensions are virtually unchanged. In other respects the need of very considerable changes has been disclosed by more extended studies of traffic, ventilation and other elements affecting design. These changes include both redesign and additions.

In redesign the most notable features were the increase of the tube shell diameter, and the change, on the New Jersey side, of the single river shaft to twin shafts. The tunnel-gases investigations carried out in 1920 and 1921 demonstrated the necessity of larger ducts for both fresh and exhaust air, than the original diameter permitted. The diameters of the under-river tubes were, therefore, increased to 29 ft. 6 in., and the diameter of the north tube in New Jersey was increased to 30 ft. 4 in. These two changes added $750,000 to the estimated cost. The change to twin shafts with the pile foundations and the relocation of the shafts added $700,000 to the cost and were required in an arrangement with the Erie R.R. for building a protecting pier and for certain easements. Another structural change was the substitution, near the junctions with shafts, to gain strength, of cast-steel for cast-iron lining and the installation in these sections of tierods. The extra cost of the steel lining and tierods is $575,000. Altogether the largest item of added cost due to redesign was for ventilating equipment. This is about $2,552,000 and was required by the tunnel-gases studies which had not been made when the estimate plans of 1919 were prepared. Additions to the plan include a tile lining costing $750,000 more elaborate designs for approach sections calling for $3,598,000 additional, widened approach roadways costing $100,000 extra and architectural treatment of approach sections costing $1,160,000.

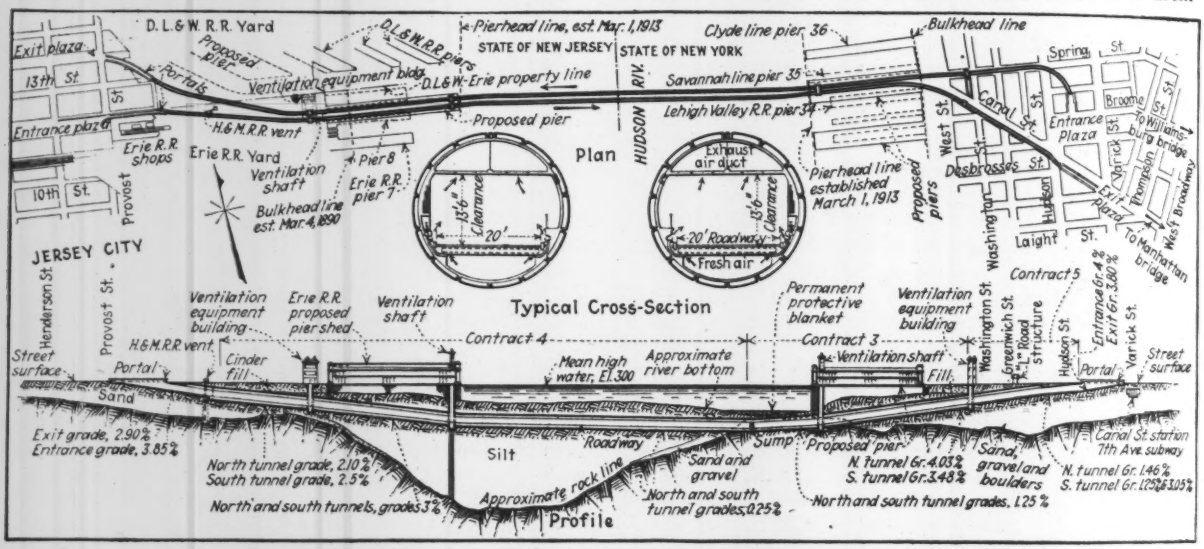


FIG. 1—PLAN AND PROFILE OF HUDSON RIVER VEHICLE TUNNEL AT NEW YORK CITY

Adding an increase in construction costs of $3,194,178, due to advances in wages and prices, and adding a number of contingent items, the total of cost increase is in round numbers $13,500,000. This gives an estimated cost, again in round numbers, of $42,000,000 for the tunnel structures planned as indicated by Fig. 1.

Of these structures the present description includes the shafts and the tunnel tubes between shore shafts and inland about 750 ft. from the New Jersey shore shafts. Three contracts were let for this work, one to the Holbrook, Cabot & Rolins Corp., for the New York shore shafts, and two, indicated as contracts 3 and 4 on Fig. 1, to Booth & Flinn, Ltd. The contract price for the New York shore shafts was $643,195 and for the combined Booth & Flinn contracts $19,331,724.

Shaft Structure and Construction—As indicated by Fig. 1 there are seven shafts. On the New York side one river shaft serves both tubes; in all other instances each tube has its individual shaft. All shafts are rectangular steel caissons with double walls filled with concrete. All were sunk by the compressed air process to seats on the natural soil or rock except the New Jersey river shafts which were set on pile foundations. The caisson sinking, carefully directed, gave astonishingly little trouble.

Putting down the shore caissons was the least hazardous of the several shaft operations. The New York structures were 42 ft. 5½ in. x 47 ft. 1½ in. and one was 57 ft. 11½ in. and the other 64 ft. 5½ in. high. The New Jersey caissons were twin structures 42 ft. 5½ in. x 46 ft. 5½ in. and 68 ft. 9½ in. high. All caissons had framed ports closed by temporary bulkheads, for the tunnel tube connections.

Both New York caissons were sunk 50 ft. under compressed air, the average daily progress being 2 ft. 8 in. for the Spring St., and 4 ft. 5 in. for the Canal St. shafts. The materials penetrated were sand and clay mixtures and every step of the sinking was straightforward. On the New Jersey side both caissons, shortly after they were put under air pressure, struck a stone-filled timber crib which went down some 40 ft. and was built to enclose three sides. Afloat the structure weighed about 1,650 tons. On location the steel walls were built up and concrete was placed until the caisson grounded at 35 ft. depth of water and had sunk about 9 ft. into the mud, the weight of the caisson displacing the material without excavation. Then air pressure was put on and excavation proceeded in the usual way and as indicated by Fig. 2.

Tunnel Driving Methods—All tunnel, except the approaches to the land shafts in New York, is shield driven. Five shields are in operation, two working west from New York and two east from New Jersey and one working west from the North tunnel shore shaft in New Jersey. The south tunnel inland from the shore shaft is completed. All shields are alike and of the general design shown by Fig. 3. A separate article at a later

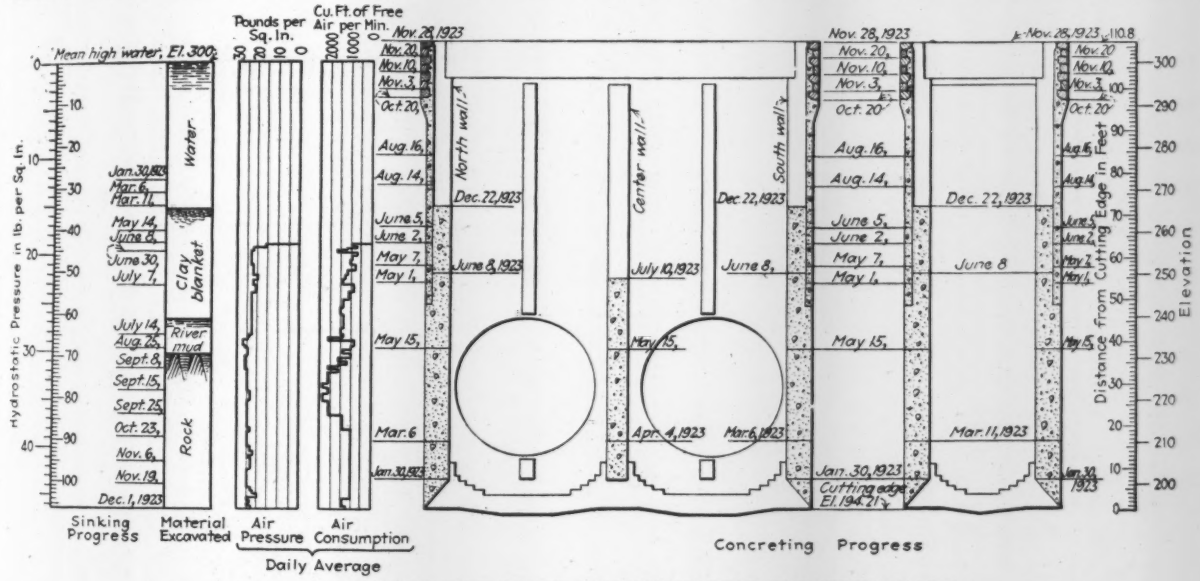


FIG. 2—NEW YORK RIVER-SHAFT CAISSON SINKING PROGRESS CHART

exceedingly difficult to excavate. Progress through this cribwork averaged less than 1½ ft. a day. One caisson was put down 67 ft. 3 in. and the other 67 ft. 2 in. below mean high water. Generally the pressures of air ran about with the hydrostatic head. There was no difficulty in sealing any of the caissons.

Difficulties in putting down the river shafts were such as came from large caisson dimensions in New York and those of building the remarkable pile foundations for the New Jersey shafts. The pile foundation structure and construction were described in *Engineering News-Record*, Feb. 8, 1923, p. 242. The caissons proper were each 37 ft. 5½ in. x 50 ft. 5½ in. and 111 ft. 5½ in. high. They correspond structurally in general with the New York river caisson as shown by Fig. 2. Both were sunk through Hudson River silt at the rate of about 1 ft. 4 in. a day without any happening of particular note except the high air pressure of 47 lb. required for sealing.

On the New York side the river shaft was formed by a single caisson, 93 ft. 5½ in. long, 47 ft. 5½ in. wide and 110 ft. 9⅞ in. high. The essential elements of the structure and the construction are given by Fig. 2. Like the river caissons on the Jersey shore this caisson was built in dry dock at Staten Island to a height of 55 ft. and floated to its site. Here a platform on piles had been

date will give details of shield structure, equipment and operation.

Tunneling operations (Fig. 4 shows the progress to April 15) divide naturally because of general differences of material into work west from New York and work east from New Jersey. In general the plan is to drive west from the New York side to about the end of Contract 3, Fig. 1, or some 2,000 ft., and then await the arrival of the shields from the New Jersey side.

In starting the New York work the ticklish task was to work the shields out of the shore caissons with the very shallow cover. The shields were erected on ways in the caissons and directly opposite the framed ports, and behind them in the caissons were set up temporarily rings of the cast lining to provide bearings for the jacks. The caisson decks were then restored and air pressure put on. The shields were handled alike and the procedure will be described for one alone.

At the caisson the material was largely fine sand which held air fairly well but the cover to the street surface was only 14 ft. and a sewer overhead cut this down virtually to 8 ft. The difficulty which confronted the contractors, with the large shield diameter, was to keep the bottom of the face dry without causing a blow-out at the top. The work being under a street, the cover could not be increased.

A bottom segment of about one-third of the steel bulkhead in the caisson opening was burned out under pressure enough to keep the face dry and then a timber bulkhead of the same size was built in front of the shield and clay was packed between it and the exposed face. Air pressure was reduced and the remaining segment of caisson-port bulkhead was removed, beginning at the top and taking out horizontal strips. As the face was exposed it was packed with clay held by breast boards and the air pressure was raised step by step. In front of the shield hood a ring cut was made in the face to the depth of a full shove and was packed with clay. This ring cut explored the material ahead for obstructions as well as sealed the hood. As the shield was shoved it moved the timber bulkhead in front times as many as 30 were removed in advancing the tunnel one ring.

Beyond the bulkhead wall the shield entered Hudson River silt. There its front was completely bulkheaded. In advancing the shield some of the silt was taken in through the lower pockets but mostly it was displaced. At once shield and lining both began to show displacement with reference to grade; the shield ran below grade and the lining rose above grade. By moving the shield bulkheads forward and lightening the shield of the weight of 50 tons of muck which was being carried in the pockets, it was possible to take in more silt without increasing the settling of the shield, and, in this way, the rising of the lining was checked. Building of the second compressed air bulkhead and weighting down

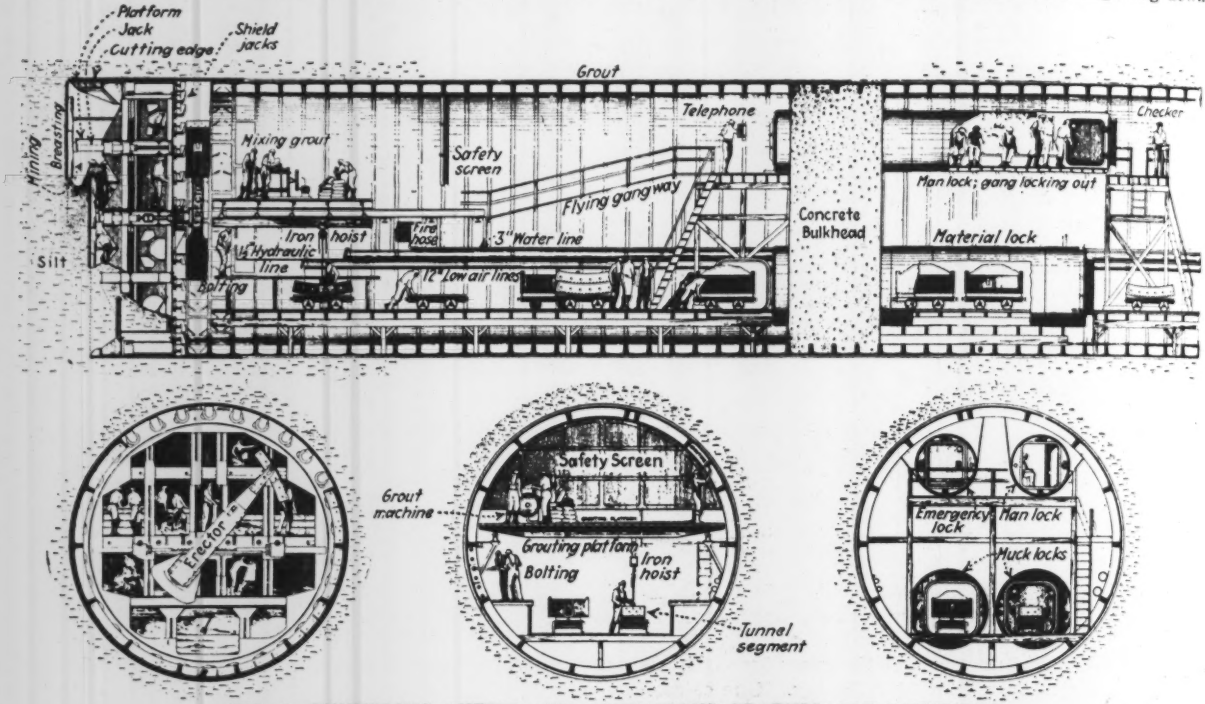


FIG. 3—TUNNELING OUTFIT AND OPERATIONS GRAPHICALLY DESCRIBED

Above: Longitudinal section through tunnel heading showing construction operations.
Below at left: Rear of shield, erection of iron and mucking in progress—center, view from rear of shield, bolting and grouting in progress—right, exterior view of concrete bulkhead showing air locks. Note the safety screen to pocket air in upper part of tunnel in case of blowout, so as to afford clear egress of workmen to man lock.

against the clay packing which was taken out over the top.

Driving continued as described until the tail of the shield cleared the caisson when grouting was begun behind the lining. This grouting was looked after religiously even to stopping the shield in the middle of a shove so as to keep the grout fill close up. There was no change in the procedure described, except to replace the movable bulkhead in front of the shield with a fixed bulkhead built in the shield, until the river bulkhead-wall foundation was reached. Owing to the careful grouting no settlement of structures occurred.

With the penetration of the bulkhead-wall pile foundation in prospect, a clay cover was deposited on the river bottom in the slip and behind the wall on the landward side. This seal was effective. In penetrating the pile foundation the only special procedure was to insure that every pile within the tunnel area was cut out to the full depth of a shove. The piles reached down to about the horizontal diameter of the tunnel and at the lining also helped the situation. It was not completely remedied, however, until the bottom of the advancing shield ran into sand overlying the rock ridge which was next cut through as indicated by Fig. 1.

In reference to the shifting of shield and lining with respect to grade, it was found to be less in the north tube where from the start much more material was taken in through the shield. In the south tube where the movement was greatest. the variation reached about fourteen inches. A feature of the movement was that the lining "rose" when the shield was advanced and when the shield stopped the rising stopped. Gage readings indicated that the jack pressures were transmitted 75 ft. back through the ground each time the shield advanced.

Passing from the silt into the part rock section, the process was to drive a bottom heading ahead of the shield and in it build a concrete cradle with embedded rails for the shield to slide upon. The remainder of the rock cut was then blasted out for a distance of two or

three shoves and the soft material on top was carefully excavating using poling and breast boards. In the cradled section the lining rests directly on the cradle. The only mishap that has occurred in the mixed section was a blowout on April 3 which delayed work a few days. There was no loss of life.

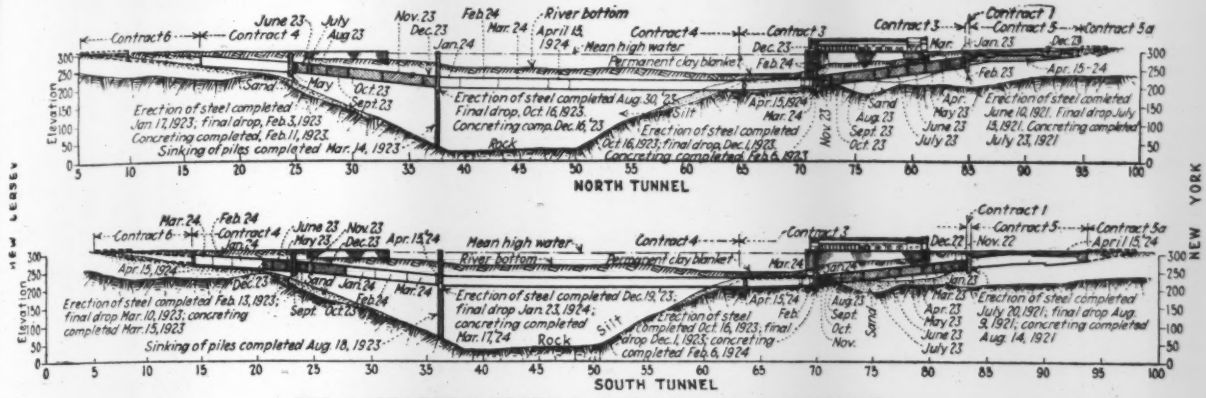

NORTH TUNNEL
SOUTH TUNNEL
Elevation
NEW JERSEY
NEW YORK
Contract 6
Contract 4
Contract 3
Contract 1
Contract 5
Contract 5a
River bottom
Mean high water
Permanent clay blanket
Sand
Silt
Rock
Erection of steel completed Jan 17, 1923; final drop, Feb 3, 1923
Concreting completed, Feb 11, 1923.
Sinking of piles completed Mar. 14, 1923
Erection of steel completed Aug. 30, '23
Final drop, Oct 16, 1923.
Concreting comp. Dec 16, '23
Erection of steel completed
Oct 16, 1923; final drop Dec 1, 1923.
Concreting completed Feb 6, 1924
Erection of steel completed June 10, 1921. Final drop July 13, 1921. Concreting completed July 23, 1921
Erection of steel completed Feb 13, 1923; final drop Mar 10, 1923; concreting completed Mar 15, 1923
Sinking of piles completed Aug 18, 1923
Erection of steel completed Dec 19, '23; final drop Jan 23, 1924; concreting completed Mar 17, 24
Erection of steel completed Oct 16, 1923; final drop Dec 1, 1923; concreting completed Feb 6, 1924
Erection of steel completed July 20, 1921; final drop Aug 9, 1921; concreting completed Aug 14, 1921

FIG. 4—PROGRESS PROFILE OF TUNNELING AND LINING

On the New Jersey side, as at New York, tunnel driving began with shield erection in the shore shafts. A view, Fig. 5, down one of the shafts shows an erecting operation. The process of removing the diaphragm in the caisson port was substantially that followed at New York.

The north tunnel shield east and the south tunnel shield west were built first and started out from their respective caissons. After the south tunnel shield west had progressed a sufficient distance to erect a tunnel bulkhead, the face of the shield was bulkheaded and the roof was removed from the south caisson and the south tunnel shield east was erected. As soon as this shield was ready, the roof was replaced on the caisson and the shield was started eastward, so that two shields were tunneling eastward, and one westward, the maximum number of shields that will be operated at one time under this contract.

FIG. 5—SHIELD ERECTION AT SHAFT BOTTOM

The method followed in starting these shields out of the shafts was similar to that already described for the New York shields except that here it was not so difficult as there was adequate cover overhead. After the roof of the working chamber had been replaced, the girders in the side of the caisson, through which the shield was to be advanced, were burned out, after which the plates were removed from the invert to the springing line. The lower pockets of the shield were then bulkheaded and the space between the pockets and the exposed face was filled with clay. After this, the remaining plates were removed, proceeding upward from the springing line. A semicircular annular ring was cleared for the hood and packed with clay into which the hood was forced when the shield was ad-advanced. The material at the face consisted of timber and riprap down to the springing line similar to the material encountered in shaft sinking, making excavation very difficult. The stones in the crib varied from one-man stones to those three-quarters of a yard in size. The voids between the stones were filled with soft black mud, which did not offer sufficient resistance to prevent the escape of air, necessitating the "mudding" of the entire face with clay. As the excavation was carried forward, the escape of air through the heading of the north tunnel at times taxed the full capacity of the power house, 40,000 cu.ft. of free air per minute. On June 10, 1923, a small blowout occurred at the face of the shield and it became necessary to drop the air pressure sufficiently to allow the water to flow in the tunnel before the blowout could be stopped. The progress through the riprap was very slow, as extreme measures had to be taken to avoid blowouts. After the shield had passed through the old timber and riprap crib, the river bulkhead wall was encountered which did not offer any unusual difficulties.

Before tunneling through similar material in the south tunnel east, 5,500 bags of 1:1 portland cement grout were ejected through the east shield bulkhead of the south caisson and six pipes were sunk from the surface east of the caisson through which 140 bags of 1:1 portland cement grout were placed. This grout dis-

placed much of the soft mud and filled the voids in the riprap and greatly facilitated the driving of the shield so that very little air escaped through this material after it had been consolidated by grouting.

After about sixty rings were erected in each tunnel, the shields were stopped to build tunnel bulkheads and to install cages at the shafts and then tunneling was resumed. Immediately east of the river bulkhead soft mud, considerably lighter than Hudson River silt, was encountered in the upper part of the excavation. In this material the tunnel began to rise directly behind the shield and also to move northward. To hold the shield and the tunnel to the proper grade, it was necessary to take in a certain amount of material through the shield. Accordingly the shield was advanced with the top pockets bulkheaded and a large percentage of the excavation was permitted to enter the tunnel through openings in the lower part of the shield. This material had to be entirely removed after each shove before the erection of the cast-iron lining could proceed, and this slowed down progress. In addition it was desired to retain this material in the tunnel directly behind the shield so as to increase the weight of the tunnel and reduce the tendency to rise.

To meet this situation a different method of tunneling was adopted. The work was stopped and a steel bulkhead semicircular in shape and fitting into the lower part of the tunnel was built to trail about 10 ft. behind the shield, and the four pockets of the shield immediately above the springing line were equipped with hydraulically operated doors. When the shield advanced, these doors were opened varying amounts, depending upon conditions, to allow the material to flow through the shield into chutes which dropped the silt back of the trailing bulkhead, Fig. 6. This method of tunneling permitted both the shield and the tunnel to be kept on grade and also made it possible for the contractor to maintain a daily average progress of about six rings (15 ft.) per working day of 24 hours. This progress was maintained until the shield approached the river shaft when it was necessary to admit material into the shaft to relieve the earth pressures set up by the approaching shield.

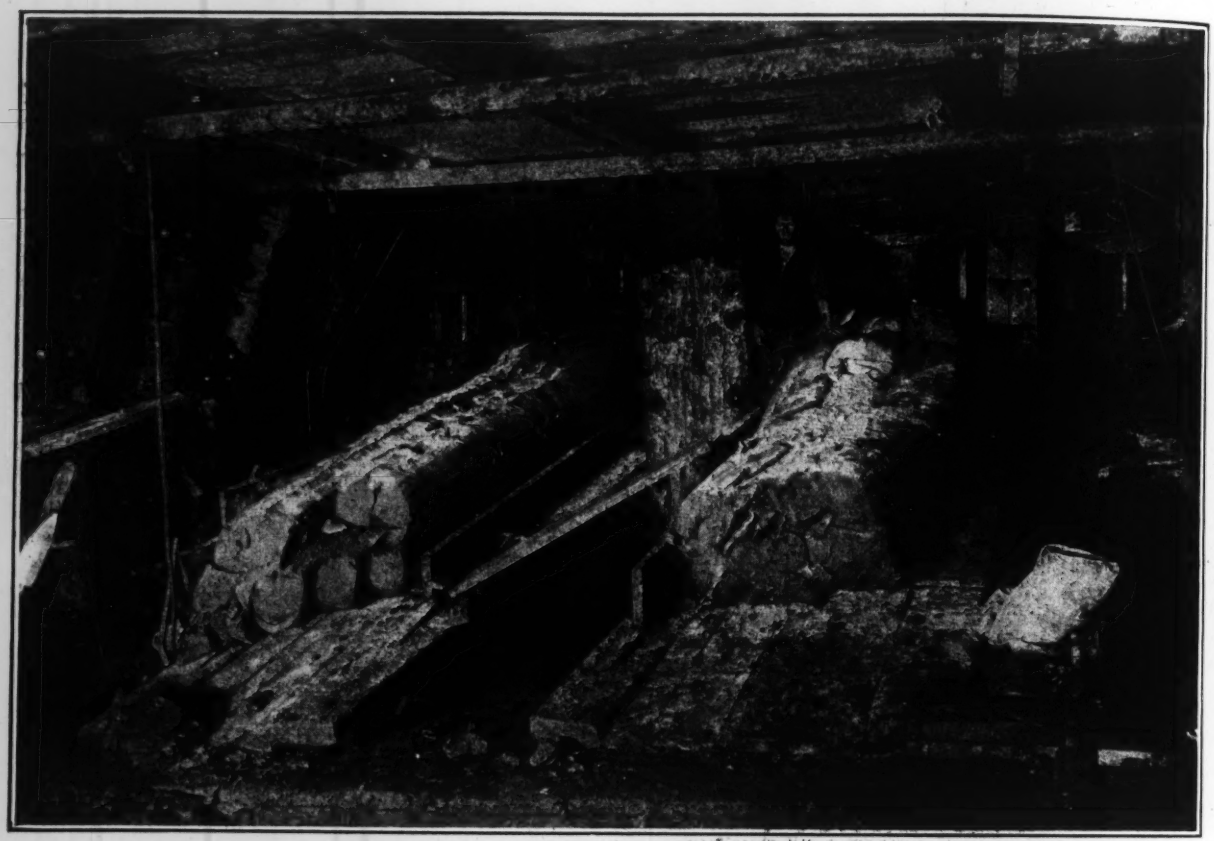


FIG. 6—ADMITTING SILT THROUGH LOWER POCKETS

Bringing the shield into the river caisson was a difficult undertaking, but was accomplished without mishap. Sufficient material was admitted into the caisson to reduce the earth pressure on the side toward the advancing shield to as near normal as possible, as determined by gages inserted into the silt so as to read these pressures. The action is indicated by the diagram

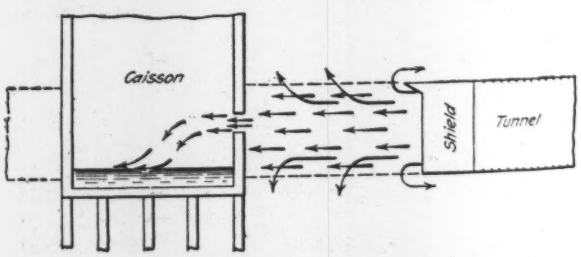


FIG. 7—SKETCH OF SOIL PRESSURES FROM SHIELD APPROACHING SHAFT

Fig. 7. As described, the caissons for the New Jersey river shafts are founded on piles reaching deep down through the silt to rock indicated in Fig. 1. The shield approaching and finding room largely by displacing the silt sets up pressures which are relieved in the directions indicated by the arrows. With the caisson blocking free relief, the pressures increase above normal as the shield draws closer. The result is an overturning action on the caisson and an increase of the normal pressures tending to displace shield and lining. To relieve these excess pressures, a port was opened into the caisson as shown by Fig. 7 and enough silt taken in to keep the pressures normal.

The experience obtained in driving the north tunnel shield was used to advantage in the south tunnel. The trailing steel bulkhead was attached to this shield at the outset and a sufficient amount of material was taken in through this shield and deposited in the tunnel behind to permit this shield and tunnel to be driven throughout on the proper line and grade.

In driving the south tunnel west shield through the caisson drum, the same procedure was followed as in the east tunnel. The south tunnel west was driven under the Erie R.R. yard. Its shield was not provided with a trailing steel bulkhead but was driven with all the pockets of the shield above the springing line and the four pockets immediately below the springing line open, allowing the material to come through the shield.

The method of driving tunnel in silt as described and as portrayed graphically by Fig. 3 is the standardized method which will continue to the end, barring accident. The outstanding novelty is the use of the trailing bulkhead behind, by which the material taken in is kept out of the shield, leaving all clear for lining erection and other operations. This method has the secondary advantage that the spoil can be left in the tunnel until pressure is removed when it can be loaded and carried out by power excavators and cars.

In lining construction there is nothing out of the ordinary practice. The lining structure was described in *Engineering News-Record*, April 6, 1922, p. 574. Great care has been taken to get tight bolting and particularly to secure precisely dimensioned segments and theoretically perfect rings. Fig. 8 shows a length of lined tube with a bulkhead wall and the two tiers of locks.

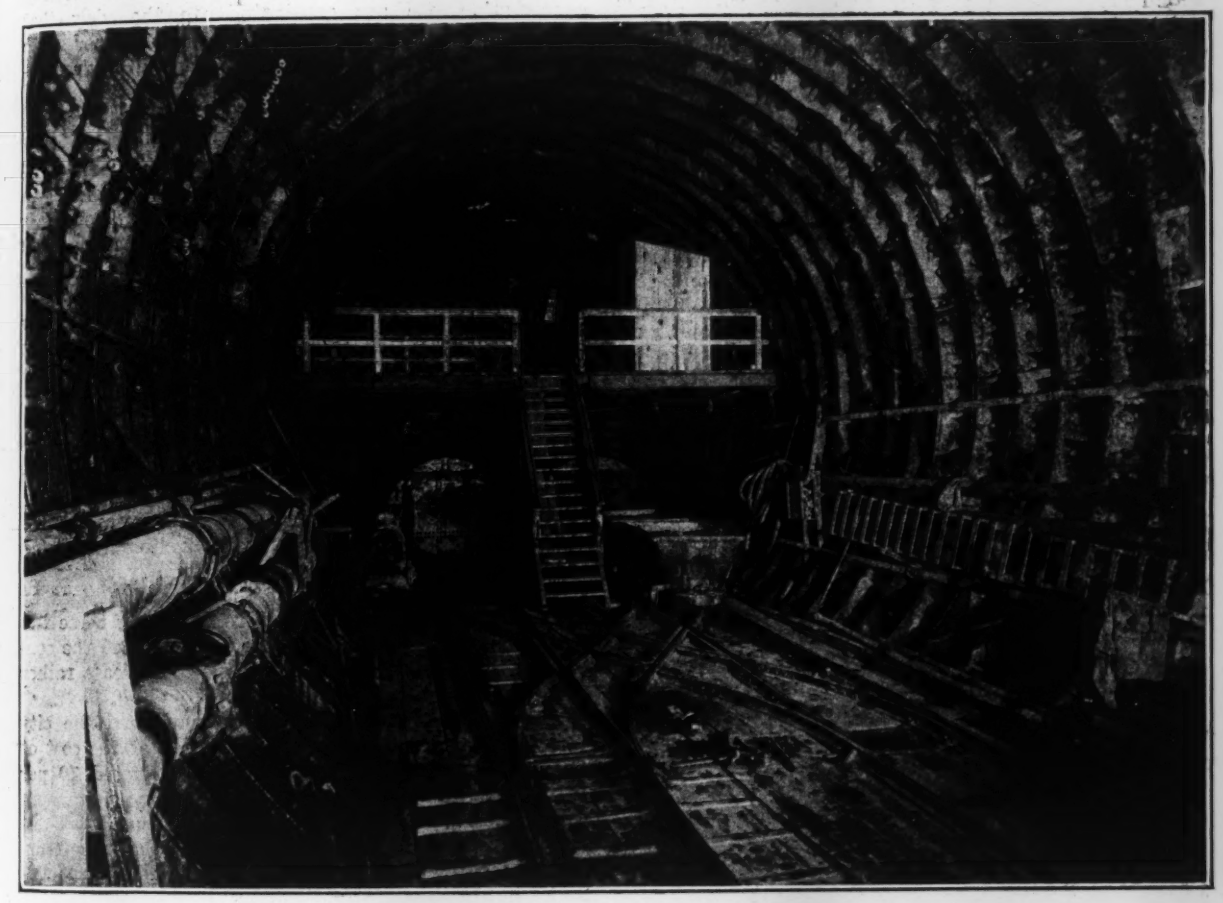


FIG. 8—SECTION OF LINED TUNNEL SHOWING BULKHEAD AND AIR LOCKS

Administration—At this time tunneling is proceeding at the rate on the New York side of one ring a day and on the New Jersey side of seven rings a day. The contractors are Booth & Flinn, with M. E. Chamberlain as engineer, M. L. Quinn, superintendent on the New York side and Le Roy Tallman, superintendent on the New Jersey side. The engineering direction, under the joint New Jersey and New York commissioners, is as follows: Clifford M. Holland, chief engineer; Milton H. Freeman, engineer of construction, and C. S. Glein and M. I. Killmer, resident engineers in New York and New Jersey, respectively.

Pennsylvania Superior Court Makes Important Valuation Decision

Court Considers Returns for Service Rendered Rather Than Amount of Return on the Property—Latter Must Be Fair

THE PENNSYLVANIA Superior Court, in dismissing the appeal of the city of Philadelphia against the decision of the state's Public Service Commission concerning a rate increase for the Philadelphia Rapid Transit Co., has rendered a decision which, while not having a direct bearing on other valuation cases outside of the commonwealth of Pennsylvania, is of quite general interest as indicative of the trend in valuation of public service properties. Moreover, the decisions of both the commission and the Superior Court are so clearly stated that they are, in themselves, valuable additions to the information on methods of determining the reasonableness of rate increases and will certainly be cited in similar cases in other states.

In 1919 the Philadelphia Rapid Transit Co. started an inventory of its properties for the purpose of establishing a plant account and on Oct. 4, 1920, filed a petition with the Public Service Commission for a new tariff. The commission authorized a temporary increase in fares, reserving its final order until the inventory of the property had been finished. Immediately following the authorization of the fare increase, the city of Philadelphia and certain civic associations joined in a complaint to the commission which resulted in a hearing extending from September, 1920, to June 1923.

For the purpose of carrying on the valuation of its property, the rapid transit company appointed a valuation committee consisting of Charles Hansel, chairman, W. K. Myers and George W. Fuller. This committee decided to price the scheduled property at prices current on June 30, 1919, and no average prices were used for periods previous or subsequent. The committee sought to furnish the Public Service Commission with the estimated cost of reproduction new as of a fixed date, so that if the commission should decide to use prices as of another date, it would have a definite benchmark from which to raise or lower prices.

Cost of Reproduction New—The committee's estimate of cost of reproduction new as compared with the estimate of the city's experts is as follows:

COST OF REPRODUCTION NEW AS OF JUNE 30, 1919

		Company's Estimate	City's Estimate
	Physical, exclusive of Engineering and Overheads	$170,756,696	$145,274,250
1	Engineering	6,787,377	5,810,970
2	Organization prior to construction	2,500,000	2,000,000
3	Administration and legal	5,976,484	5,084,599
4	Taxes	1,650,000	800,000
5	Interest during construction	22,329,736	15,896,982
6	Loss of fair return	15,013,644	00
7	Working capital	4,740,374	3,755,414
8	Financing (cost of obtaining money)	22,975,431	8,931,111
	Eight items above	$81,973,046	$42,279,076

These figures were presented to the Public Service Commission which, after discussing the importance of giving consideration to the cost of reproduction new, said: "This brings us to a consideration of the evidence offered by the respondent with reference to the estimated cost of reproducing its property today at present prices. Here we approach a field involving much less risk of error and it is not surprising to find that, with regard to the inventory so carefully prepared by the company, the city has no substantial dispute, and as to the unit and total prices applied to many items of that inventory the parties are in substantial agreement."

The city sought to impress the commission that more consideration should be given to original costs and that it was possible to find such original costs. The commission, however, did not consider this of as much importance as did the city and said: "In the case of properties which have been constructed, added to and developed over a long period of years, involving as in the present case more than two generations, with vast fluctuation in price levels and other conditions affecting construction, we are constrained to the view that original cost, even if it could be ascertained with approximate accuracy, cannot be accepted as furnishing the controlling measure of present value."

In the matter of loss of interest during construction, an item which the city did not consider should be included, the commission said: "Loss of interest during early years. This item, which represents the lag in the development of patronage and earning power, is placed by the company at the equivalent of one full year's interest at 8 per cent, to wit: $15,000,000. It is entirely ignored by the city. . . . While, therefore, we are constrained to allow interest charges for the early and initial period of operation . . . we must point out that it is in reality one of the elements of what is commonly termed 'going concern value,' and, therefore, it must not be duplicated when the important question is considered."

In discussing going concern value and depreciation, the commission said: "We are further of the opinion that in the present case where the evidence establishes a minimum of depreciation and the maximum of going concern value, that the latter substantially offsets the former in any adjustment of the figures obtained by physical valuation, and, therefore, weighing these two questions against each other, we have reached the conclusion that the net result would be to increase rather than diminish the amount."

Another item on which the company and the city were at considerable disagreement, that of the cost of financing, the company's committee estimated 10 per cent of the entire reproduction cost, exclusive of going concern value, while the city estimated 5 per cent. In its review of the case, the Public Service Commission took the mean of the two amounts giving 7½ per cent as its figure.

Commission's Conclusions—The conclusions of the Public Service Commission, insofar as they bear on the major factors of valuation, are as follows:

1. We do not find it necessary in this proceeding to arrive at a final determination of the present fair value of the property of the company. However, our consideration of the items of evidence before us, including the questions of depreciation and going concern value and of matters in dispute between the company and the city, lead us to the conclusion that under established legal principles the present fair value of the company's property is substantially upwards of $200,000,000.

2. With regard to operating expenses we are not disposed to interfere with the budget submitted by the company as long as it continues its present policy of improved service and a high standard of maintenance.

3. In this connection we are of opinion that the company has established its right to share in additional profits resulting from approved economies and efficiencies in its operation. . . .

The right of the company to continue to collect the fares thus established and in effect is confirmed and the complaint dismissed.

Action by the Superior Court—The Superior Court of Pennsylvania, in an opinion rendered by Judge Linn, in the appeal from the order of the Public Service Commission by the city of Philadelphia and various intervenors, said: "The city and the intervening appellants are in such close accord in gathering from the evidence a rate base sufficient to sustain the challenged rate, that but little need be said in recording our unanimous conclusions that this appeal should be dismissed. . . . At the outset, we note, that several elements frequently disputed in rate cases are not questioned in this case; appellants do not contend (1) that the service is inadequate, or the property inefficiently operated; or (2) that the fares charged are more than the service is reasonably worth; nor (3) is there any basis to contend that incompetent evidence materially affecting the issue was considered by the commission. The court said further:

The appeal brings up only one contention, which is, that the rate charged is unreasonable in the sense that it yields a larger net return than appellants think should be earned on the fair value of the property devoted to the public service. But that is not an accurate test of an unreasonable rate at the complaint of a patron. "The company is entitled to receive a reasonable return for the services it furnishes, and no more; the public is entitled to receive an adequate return for the reasonable rate it pays and no more." . . . "What the company is entitled to ask is a fair return upon the value of that which it employs for the public convenience. On the other hand, what the public is entitled to demand is that no more be exacted from it for the use of the public highway than the services rendered by it are reasonably worth." (Smyth v. Ames.) As to the company, rates are unreasonable, if they yield less than a fair return on the value of the property used and useful in the public service. In such cases, the value must be found as a base from which to determine whether the rates are reasonable or not. But the present appeal does not involve that inquiry. As has been stated, it is not contended that the service is inadequate, or the property inefficiently operated, or, what in this case is of greater importance, that the fares charged are more than the service is reasonably worth.

If, however, we examine appellants' contention that the rates charged yield a higher net return than is justified by the fair value of the property, the inquiry at once is—what is that value? The commission did not determine definitely what is is, because, during the investigation, it found respondent's property was worth more than the sum required to justify charging the disputed rate; it did, however, find that, for rate-making purposes, the value was "substantially upwards of $200,000,000"; the record contains evidence supporting that conclusion. At figures shown in the report, in 1922, the rates charged earned, net, 7 per cent on only $126,000,000; although all appellants concede that the value of the property was much greater; for 1923, the estimated net return was 7 per cent on $158,000,000. At the oral argument, counsel for the city informed the court that the evidence justified a rate base of from $135,000,000 to $138,000,000; counsel for one intervening appellant in his brief states it at $133,000,000 while another puts it at $153,000,000. An expert who testified for the city, stated that the cumulative total investment alone, was in excess of $128,000,000, without including a surplus of over $11,000,000 invested in capital expenditures. Those concessions, frankly and commendably made, are not without convincing effect in an inquiry such as we must make, where the statute prescribes that the order of the commission is prima facie reasonable, and imposes on appellants the burden of establishing the contrary. Considering the public importance of the case, we shall not—as we might—rest our decision on those concessions alone; we mention them, however, to show there is no substantial difference between the parties to this appeal.

Let us re-state the problem. The city asked the commission to fix a reasonable rate; it did so for a trial period; respondent adopted that rate finally; the investigation then proceeded on that rate and the commission held it reasonable; the statute makes the order prima facie valid. Now, what is urged to destroy that prima facie validity?

First, it is said the commission made no definite valuation. The law does not require one: . . . it may be made when necessary or desirable. If in the course of its inquiry, the commission finds, as it did in this case, that it has sufficient evidence to act finally, nothing can be gained by thereafter wasting time and money in unnecessary investigation. . . .

Fourth, objections are made to the force attributed to certain items of valuation; we consider them without merit on this appeal, and shall refer to only one—to the expenditure of $14,000,000 for street paving prior to the agreement of 1907. Of this, the commission said: "The city, in its historical studies determined, to its own satisfaction, that the actual cost of this paving so laid was in excess of $14,000,000. The company claimed for the item of paving nearly $26,000,000. . . . In such cases we feel that all the company can claim to have protected is its original investment or price paid for the franchise, and we, therefore, can give no consideration to the higher figures which it is admitted the present cost of paving would reach." Appellants have no cause to complain of that; it is not unlawful to capitalize the amount paid for franchises. . . .

The net result of the decision of the Pennsylvania Superior Court is to establish, for Pennsylvania at least, the principle that it is not necessary to go to the expense of a final determination of the present fair value of that portion of the property of a public service corporation devoted to the uses of the public once it has been established that the existing rates are reasonable for the service rendered; and that a public service corporation is entitled to share in the additional profits resulting from approved economies in the operation of its properties.

Recommends Storage Reservoir for Flint

SHOULD the low water period of 1911 experienced at Flint, Mich., recur, a water famine will ensue since the present consumption and the low flow from the Flint River, the present supply, approach the same figure. George A. Johnson, consulting engineer, in a report dated Feb. 21 on an additional supply, presents the following conclusions and recommendations:

In 1950 the present population of 130,000 will have increased to 300,000 and the present 13.5-m.g.d. consumption to 37.2-m.g.d. No other source than the Flint River is worth consideration but as at present utilized it is not adequate. With a storage reservoir of 1,856-m.g. capacity above Genesee, formed by a concrete dam with its crest 26 ft. above the river bed, sufficient water may be impounded to provide during a protracted drouth for 368, 140, 81 and 55 days, respectively, in 1930, 1940, 1950 and 1960.

On the catchment area of Flint River there is a population of 38 persons per square mile. The reservoir planned will be shallow but the anticipated algal growths can be controlled by copper sulphate. Ripple aeration at the dam will offset the effects of stagnation of the stored water and the existing filter plant will remove satisfactorily the reduced suspended matter, color and bacteria at lower cost for chemical costs than now.

Cost of the dam, 1,800 ft. long, purchase and clearing the flooded area are estimated at $1,250,000. Immediate action was recommended, for at best final surveys and plans cannot be ready for a contract before August of this year and the work completed in time to benefit from the flood water of 1925. Thus 1926 is the earliest date benefit may be derived from the storage.

The report was made on the initiative of F. N. Baldwin, chief engineer and general superintendent to the Board of Water Commissioners.

New Sounding Tube Devised for Hydrographic Surveying

Capillary Block Is Added Feature Which Gives Device Accuracy in Measuring Water Depth

By G. T. Rude
Lieutenant-Commander, U. S. Coast and Geodetic Survey, Washington, D. C.

FOR HYDROGRAPHIC surveying in depths not exceeding 600 ft., the U. S. Coast and Geodetic Survey has recently developed a sounding tube which, like all sounding tubes, is conceived on the fundamental principle of balancing the pressure of the water at a given depth against the pressure of compressed air. The fundamental differences between this tube and those of other makes lie in the method of trapping the water, of ascertaining the amount of water in the tube, and the use of stock brass pipe of standard bore. It has been found that stock brass pipe may be obtained within 0.001 in. of a uniform bore, which permits using a standard measuring device with all these tubes. For this reason the brass pipe has proven more satisfactory for surveying purposes than the glass tubes commonly used in many sounding devices.

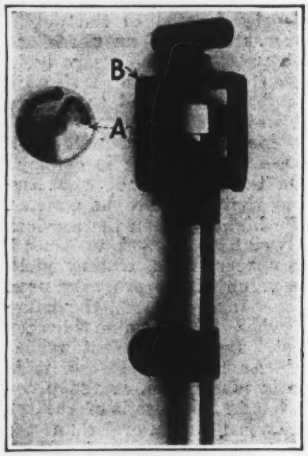
Characteristics of Sounding Tubes—Sounding tubes in general use are of such a length that the column of air is about 24 in. long. Some tubes are composed of a glass tube inclosed in a metal case; others consist of a metal tube only. The tube, which is full of air of the same constitution, temperature, and pressure as the air near the surface of the water, is attached to a lead which is dropped to the bottom by means of strand or piano wire, without stopping the vessel for the cast. The tube is sealed at one end and has a small opening at the other. The pressure of the water as the tube descends compresses the air in the tube, the water entering to occupy the space left as the air recedes under compression. The relative amounts of air and water in the tube determine the water pressure, from which the depth may be readily deduced by measuring the amount of water trapped, by any suitable means. The fundamental differences between tubes of different makes lie in the methods of measuring this water which has been trapped as the tube descends.

In some types of tubes of small bore, the water rising in the tube leaves a record of the maximum height reached by it. This is accomplished by having the inner surface of the tube of ground glass which is wetted by the water rising in the tube, or the inner surface coated with a substance which changes color upon contact with sea water. In each case an automatic record is left of the height to which the water was forced under pressure. In other types of tubes of larger bore, the amount of water is read directly on the graduation of the glass tube container or trap; in still others by inserting a rod into the tube until the water overflows, and reading on a scale this length of rod inserted.

Many of these sounding tubes have been tested for use in hydrographic surveying. These tests have proven the tubes unsatisfactory and not of the desired accuracy for this purpose because of the non-uniformity of bore, because of the fact that the physical conditions at the bottom are not those near the surface, and because the barometric, temperature, and density conditions are not comparable with the normal conditions upon which the computations were based for graduating the measuring device.

Coast and Geodetic Survey Tube—The Coast and Geodetic Survey sounding tube and the method of use were developed for the purpose of obtaining results at all times sufficiently precise for surveying purposes. This tube embodies the principles of the tube designed by E. G. Fischer, formerly chief of the instrument division of the Survey, as to uniformity of bore, and the capillary-block principle devised by the writer, this capillary block replacing the cap and poppet valve of Mr. Fischer's tube.

In the Fischer design a light spring closes this poppet valve when the tube reaches the bottom and the entrapped water and compressed air are brought to the surface at the pressure corresponding to the depth of water; in the design of the writer the capillary block, a small brass block (*A* in the figure) in which an annular capillary groove has been constructed, admits the water to the tube through this capillary canal as the tube descends. The water is trapped in the bottom of the tube; but in this design there is no mechanical valve and the compressed air is allowed to escape as the tube is brought to the surface, so that the pressures inside and outside the tube are practically equalized at all times.



NEW SOUNDING TUBE FOR HYDROGRAPHIC WORK

The tube itself is essentially a stock brass pipe ½ in. inside diameter and 24 in. long, sealed at one end. The cap, in which the capillary canal is constructed, closes the other end and is held in place by a stirrup and thumb screw (*B* in the figure).

For measuring depth as determined by this tube, uncorrected for abnormal barometric, temperature, and density conditions, a brass rod ⅛ in. in diameter, on which is mounted a sliding marker, is inserted in the sounding tube after the capillary block has been removed, until the water in the tube rises to the level of the open end. The marker then indicates the length of rod which is measured on a special scale, graduated to read the depth determined by the tube, uncorrected for abnormal barometric, temperature, and density conditions.

Correction Graphs—Since the physical conditions in the field are seldom, if ever, similar to the normal theoretical conditions upon which the computations for the measuring scale are based, and further, since it is impracticable to determine the physical conditions at the bottom where the sounding is made, the ordinary sounding tube has heretofore proven of little value for surveying purposes, although sufficiently accurate for navigation.

This tube with the capillary block has been tested and the indications are that the necessary accuracy for surveying purposes has been obtained when the tube

is used in connection with a correction graph for barometric, temperature, and density conditions of the field. This graph is constructed on large scale cross-section paper from occasional upright casts of the lead during the time the sounding is in progress. The readings of the occasional upright casts, or actual depths, are plotted on the axis of X, and the simultaneous tube readings on the axis of Y, the differences of the resulting curve or line from the normal 45-deg. line, constituting the correction to be applied to the tube soundings taken during that day.

Analysis of 16,500 Road Accidents in Connecticut

One Motor Vehicle in Twelve Last Year Was In An Accident—Driver To Blame in Seven of Every Ten Accidents

THERE have been 50,000 motor-vehicle accidents in six years in Connecticut, counting only those in which persons were injured or the property damage was at least ten dollars. Some 17,000 of these accidents occurred in 1923 and in them 280 people were killed, 500 were seriously injured and more than 3,500 were slightly injured. The property loss by these accidents was $1,500,000, and this is probably about 20 per cent of all pecuniary losses including death, recovery from injuries, and loss of time and of vehicle service. Loss of life alone is estimated at four million dollars.

These in brief are the astounding results disclosed in an analysis, by the civil engineering department of Yale University, of the accident records of the commissioner of motor vehicles of Connecticut. As reported by Prof. John C. Tracy at the conference, on April 9, 10 and 11, on motor vehicle traffic the details may be summarized as follows:

The total number of accidents increased from 2,000 in 1918 to 16,500 in 1923; the number has doubled in the last two years. Expressed in percentage of registration, accidents have increased from 5 per cent in 1921 to nearly 9 per cent in 1923. One car in twelve was in an accident in 1923. The number of accidents for the first three months of 1924 compared with the number in the corresponding period of 1923 was:

Year	Total Number	Fatal
1923	1,920	16
1924	3,022	45

The number of fatalities due to motor vehicle accidents has increased from 33 in 1910 to 280 in 1923. During the same period accidental deaths from all other causes have decreased from 941 in 1910 to 769 in 1923. The number of fatal accidents due to motor vehicles in the period from 1910 to 1923 exceeded 2,200. The motor vehicle accident death rate increased from 3 per 100,000 in 1910 to 18 per 100,000 in 1917. Since then it has remained nearly stationary. In 1910 there were 5 times as many deaths from typhoid as from motor vehicles, but in 1923 there were 5 times as many deaths from motor vehicles as from typhoid.

The greatest number of accidents occur during the summer and early fall, reaching the peak in August. For the last 9 months of the year the most accidents occurred on Saturday and Sundays, but for the first three months they were more frequent during other days of the week. The latter part of the afternoon is the period of the day when the most accidents occurred and the peak was reached at approximately 5 o'clock throughout the year. For the fall and winter months there is a minor peak of accidents for an hour before and after midnight.

Of the 16,500 accidents, more than 10,000 (70.5 per cent) were the fault of the operator; nearly 3,500 (22.8 per cent) were the fault of other persons; 600 (4 per cent) were due to defective equipment; and the remainder (only 2.7 per cent) were due to miscellaneous causes. Of the accidents resulting in death or serious personal injury 47 per cent were the fault of the operator; 46 per cent were the fault of other persons; 3 per cent were due to defective equipment; and 4 per cent to all other causes. (Statistics for the first three months of 1924 show that 32 per cent of fatal or serious accidents were due to the operation and 61 per cent to other persons.) There were 2 times as many accidents in proportion to registration from commercial cars as from private cars, and 1⅓ times as many from public service cars as from private cars. Approximately one-third of the accidents in New Haven, Hartford, and Bridgeport (cities on the main trunk line) were due to cars registered in states other than Connecticut. The 600 accidents due to defective equipment are distributed as follows: Defective brakes 174; defective steering gear 104; glaring headlights 61; insufficient light 69; miscellaneous defects 191. Defective equipment was responsible for 5 fatal accidents and for 15 which resulted in serious personal injury.

Of the 7,675 accidents from the largest cities, collisions were distributed approximately as follows: With other motor vehicles 4,700 (including motor cycles); with pedestrians 1,400; with trolley cars 650; with bicycles 300. During January and February, 1924, the total number of accidents was 834 and the causes were distributed as follows: Disregard of rules of road 36.8 per cent; skidding 13.7 per cent; inattention 13.5 per cent; failure to signal 6.7 per cent; careless backing 6.0 per cent; too fast for conditions 5.4 per cent; following too closely 5.3 per cent; driving on wrong side of road 3.1 per cent; confusion 2.4 per cent; cutting in 1.8 per cent; inexperience 1.7 per cent; intoxication 1.1 per cent; cutting corners 1.0 per cent; miscellaneous 1.5 per cent.

Fast driving and semi-intoxication, however, may be contributing causes of accidents for which some other cause such as skidding is given as the primary cause.

The causes of 108 of the 131 deaths in 1923 for which the driver was to blame are distributed as follows: Skidding 26; vision obscured 20; too fast for conditions 14; inattention 8; inexperience 8; intoxication 6; trying to beat train 6; wrong side of road 5; leaving road 5; failure to give right-of-way 4; confused mentality 4; failure to signal 1; too close to another vehicle or object 1. The remaining 23 have not been definitely classified.

The number of deaths from motor vehicles to April 1, 1924, exceeds the number for the corresponding period of 1923 by 29, so that if the number for the remaining 9 months of 1924 is neither greater nor less than for the corresponding 9 months of 1923 the total number of deaths for 1924 will be 299. From present indications the number will be considerably over 300.

Transmission Line Surveys and Field Engineering

Preliminary Paper Location—Instrument Surveys, Records and Mapping—Two Parallel Profiles—Field Parties—Office and Field Location of Towers—Work of Engineers on Construction

By Ole Davidson
Superintendent of Construction, Indiana Electric Corporation, Indianapolis, Ind.

ON THE NEW 75-mile high-tension transmission line from Terre Haute to Indianapolis, Ind., constructed for the Indiana Electric Corporation, the field engineering may be considered under the following heads: Preliminary field work, actual surveys and mapping, tower locations, and the sagging of the cables. The source of the electrical energy to be transmitted is a steam station on the Wabash River, about eight miles southwest of Terre Haute. The main distributing point is a substation about five miles south of the center of Indianapolis. Two tower lines 110 ft. apart are contemplated, for which a 200-ft. right-of-way has been secured.

Maps and Property Records—Maps covering territory in the vicinity of the contemplated line were secured from various sources. The best maps were blue-line white prints procured from the U. S. Post Office Department, showing rural routes. These maps, which are by counties and plotted to a uniform scale of one inch to the mile, were cut and pasted together to make a continuous map for the entire line. On this map an ideal line, as nearly straight as possible between termini, was so plotted as to miss the state lands and two small villages.

In the meantime, information procured from county records as to property ownership and assessed land values was shown on 8½ x 11-in. sheets of medium white bond paper. Each sheet was printed with two sections (subdivided into "40's") to a scale of 1,000 ft. per inch. Automobile speedometer surveys were made along the roads to locate the improvements for a distance of about a mile on each side of the ideal line and the results were plotted on the sheets. Blueprints made from these sheets were pasted together for a continuous map on which the ideal line was laid down, but it was necessary to make slight deviations from that line to miss the improvements.

It was decided that it would not be advisable to make instrument surveys until options for right-of-way had been secured. Accordingly this blueprint map, with the proposed line following closely the ideal line, became the base map and from it were taken the descriptions in the options. When the speedometer work was done carefully on roads that ran along the land lines, very little difficulty was experienced in hitting the points desired and missing the improvements. When the roads did not follow land lines it was impossible to make as accurate a speedometer survey, and in these sections more preliminary instrument lines had to be run. No aerial mapping was done as in the transmission-line survey work described in *Engineering News-Record*, Feb. 28, p. 360.

A general map on tracing cloth, 11 in. wide and on a scale of 4,000 ft. to the inch, was then made, showing land sections, improved and unimproved roads, railroads, streams, villages, counties, school houses, churches and cemeteries. The right-of-way was shown prominently by two parallel lines; the working bases or camps, by stars; and shipping points by triangles. This map was also used for recording progress, as mentioned later.

Survey Methods—Instrument surveys were started when sufficient right-of-way had been covered by options. The center of the north tower line was the transit line. Hubs were set in every fence, and stakes at each 100-ft. station. Pluses and angles were taken to all property lines, roads, railroads and pole lines. Note was made of the nature of the land; whether cultivated, meadow, pasture or timber land. Property owners' names were secured by field parties to compare with information from the county records. Levels were taken on two lines 15 ft. on each side of the transit line. The object of this was to get the profile under each lower conductor so as to obtain proper clearance when spotting the positions of towers. Height, number of wires and kind of service was noted for each pole line crossed. The survey notes were plotted on stock sheets of tracing cloth, the maps and profile being on the same sheet with a horizontal scale of 200 ft. to the inch and vertical scale of 20 ft. to the inch.

Each field party consisted of a chief of party, an instrumentman, two chainmen and two helpers. The procedure was to run out a portion of the transit line between controlling points; then while the instrumentman was taking the levels the chief of party with the others would be taking ties to land corners and property lines. Three parties were used, each covering about twenty-five miles of line. Each party had a motor truck of 1,500 lb. capacity. Surveys were started in March and lasted until July, since considerable clearing had to be done where the line ran through wooded country. The average performance was 2,000 ft. of completed line per calendar day, which included all preliminary lines and all changes.

Locating the Towers—While the surveys were in progress, the height of tower, length of span, size of conductors and allowable tension, sag and clearance were worked out in the engineering office. It was decided to use an 80-ft. tower and a maximum sag of 27 ft. for a standard span of 800 ft., giving a ground clearance of 22 ft. The tower was designed to carry six 4/0 copper conductors and one ⅜-in. galvanized ground wire. The height from the ground to the lower conductor at the tower is 49 ft.

To facilitate the spotting of tower locations on the profile a transparent celluloid curve was made, the lower edge of which was a parabolic curve conforming to that which the cables would take under the maximum tension of 5,000 lb. This curve had to be on the same scales as the profile. On the celluloid were inscribed two other curves, parallel with the curve of the lower edge. One was 27 ft. above and the other 49 ft. above the edge, measured vertically or parallel with the axis at all points. This celluloid curve would cover up to a

1,600-ft. span. To use this curve in spotting towers, a point was located on the ground line which would be the location of a tower; then the lower edge of the celluloid curve was placed on this point (always keeping the axis vertical) and moved until the middle curve touched the ground line of the profile. The other point, at which the lower edge of the celluloid curve intersected the ground line, was the location of the next tower, and the upper curve showed the position of the lower conductors and was 22 ft. from the ground line.

The spotting of towers is a matter of cut and try, working back and forth over the particular district. Usually there are controlling conditions which necessitate the location of a tower at a particular point to give certain predetermined clearances. For example, there are roads, railroads, telephone or other pole lines; then there are natural features such as creeks, ditches, side hills and outcroppings of rock; again, the right-of-way settlement may govern the location of a tower or towers. The fundamental idea is to cover the greatest amount of line with the least number of towers. The results of tower spotting on the profile were transferred to tower sheets, 8½ by 11 in., on tracing cloth. On these sheets columns were provided for the following items: Tower number, kind of tower (standard or anchor), mile post, station, grade, number of insulators, property owners and remarks. A later design carried two additional columns for length of span and sag at 60 deg. F.

These tower sheets were the most important collection of information on the job and the reasons for each column may be given: Tower number and kind are self evident; station and grade are used by the field engineers in staking the towers for construction; mile post is of incalculable service in spotting cable reels for stringing; number of insulators shows whether it is a suspension or dead end tower, besides giving information to the material distributing department; the property-owner column is used by every one, as frequently the construction forces cannot work on certain properties and the owner's name means more than a tower number. In the remarks column are noted roads, railroad crossings, telephone crossings, and angles and equations in the line. In fact, there is sufficient information to reproduce the transit line. The added columns of span and sag are essential during the stringing and sagging of the cables.

When the information was transferred from the profiles to the tower sheets the number and kind of tower and name of property owner were inked in. The station, however, was shown temporarily in pencil. The other columns were disregarded for the time being. Blueprints were taken and the field engineer "flagged" the tower locations as shown on the plan, making notes of suggested changes. The assistant superintendent then accompanied the field engineer over the line, inspecting the tower locations and changing them when necessary. In but few cases were tower locations changed more than 25 ft. from those worked out in the office on the profiles. These slight changes were to give better foundation conditions, sometimes to miss stumps or rocks. After this inspection the stations as changed were inked in on the tower sheets, thus showing at all times which towers were finally located. The remaining information was then filled in.

Base Line for Reference—During this period of surveys, plotting of notes and tower spotting, and prior to actual construction, the descriptions for the final easements were written. In these descriptions the north tower line was used as the line of reference instead of the center line of the 200-ft. right-of-way. Two reasons prompted this. In the first place, the survey was along the tower line and all angles and land ties were made to it, so that to change to the center line of the right-of-way would have involved long trigonometric calculations. In the second place, the tower line would be the visible feature in future work, such as checking up descriptions. Right-of-way documents were numbered, using mile posts and decimals, all documents referring to one ownership having the same number. These numbers appeared also on the plan-profile sheets.

Tower Erection—Construction work was not started until final settlements were made for the right-of-way. When sufficient right-of-way had been secured, towers were staked at the locations given by the tower sheets, the grade being determined in the field and a grade stake set for guidance of the construction forces. In staking tower foundations, the field engineer set enough stakes so that the construction forces had no measurements to make, using only templets which were uniform for all towers. The field engineer inspected every foundation and reported conditions. The standard tower foundation is a built-up galvanized steel pyramid for each tower leg, set 7 ft. in the ground. In a few cases reinforced-concrete was placed in the holes, when the subsoil, such as fine sand or muck, would not resist the vibration of the tower.

During tower erection the engineers were completing their field information on footings, checking up clearing and removal of dangerous timber. During the stringing they were engaged in getting the cables to the proper sag. No dynamometer was used. Sag tables were prepared for a variation of ten feet in span and for a variation of 10 deg. in temperature from zero to 90 deg. F. This work required a great deal of patience and perseverance. The field engineer also did the final inspection of construction work.

Progress Records—At the bottom of the general map a profile was drawn showing each tower in outline extending below the ground line. Three curved lines were drawn between the towers to represent the cables. From this tracing a white line brown print (negative) was taken and a brown line white print from the negative. On this white print the progress was shown by filling in with black ink. The following progress items were shown: Right-of-way secured; clearing completed; tower foundations set; towers erected; and cable strung. Blueprints were taken of the white print to show progress at any desired date. This method simplified the keeping of progress on the various items and avoided the coloring of numerous prints at the end of each reporting period.

It was the purpose of the engineering staff to plan every possible portion of the work, such as spotting of cable reels, length of jumpers, location of grounds, dead end and pulling points. Experience has shown that a definite plan, even though it may be slightly altered by the foreman in charge, is very essential to proper co-ordination and progress.

Kelsey, Brewer & Co., Grand Rapids, Mich., are the constructing engineers; L. B. Andrus is vice-president and chief engineer; F. G. Dana is general superintendent.

Repairing a Skewed and Displaced Bridge Roller Bearing

New Rollers Placed In Bearing of 250-Ft. Span With Cam Teeth Engaging Shoe Plates To Maintain Alignment

By Charles F. Draper
Structural Engineer, Montreal, Quebec

In existing bridge expansion bearings where the roller nest has been installed without any device for control of its movements, it is a common experience to find that the rollers become displaced in various ways from their correct position relative to the upper and lower bearing plates. Lateral displacement has usually been provided against by forming tongues on the plates and turning corresponding grooves in the rollers. These, however, permit the rollers to skew, the grooves at times being found jammed on the tongues, and more frequently the roller nest is found bodily displaced in the line of travel. These displacements are more apt to occur where no provision has been made for distributing the load uniformly over the rollers by disk bearings or by other means which will minimize the tendency to initial slipping between plates and rollers.

Various devices incorporated in the design of the members have been used in the more modern structures to provide against relative displacement. It becomes a more difficult matter, however, to provide against such displacement where no controlling mechanism has been originally provided.

The view Fig. 1 illustrates a method which has been used in the case of a 250-ft. span and has proved effective in keeping the rollers normal to the line of travel and in their correct position relative to the bearing plates. In this case the length effective for expansion is 500 ft., due to the combination of the opposite end of the span with the expansion end of the adjoining span. Additional travel was thereby made necessary, and somewhat larger cams and slots were consequently

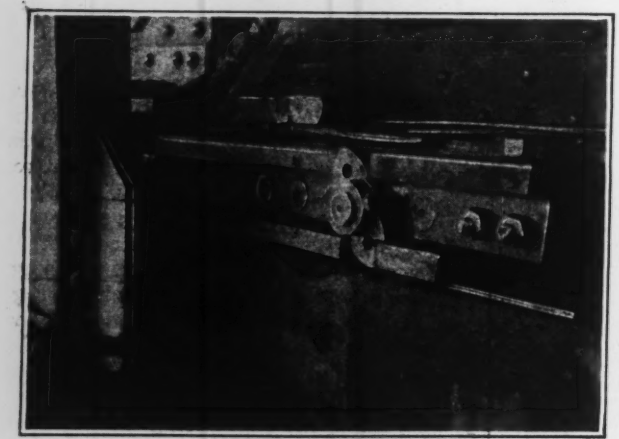


FIG. 1—ROLLER BEARING AFTER REPAIR, FITTED WITH CONTROLLER

required. The roller nest comprises nine rollers of 3½-in. diameter, 3 ft. 5¼ in. long; the width of cams and slots is 3 in. The two existing roller nests were found to be considerably displaced. The rollers were skewed, the grooves being jammed on the tongues, as well as one roller being found broken, and both nests protruded bodily from the bearing plates.

Owing to the condition of the rollers, it was decided to replace them, thereby necessitating jacking up the spans. Previous to the jacking the new rollers, side bars and cams were assembled on the pier, and the slots cut in the edges of the upper and lower plates in their correct relative position. The ends of the

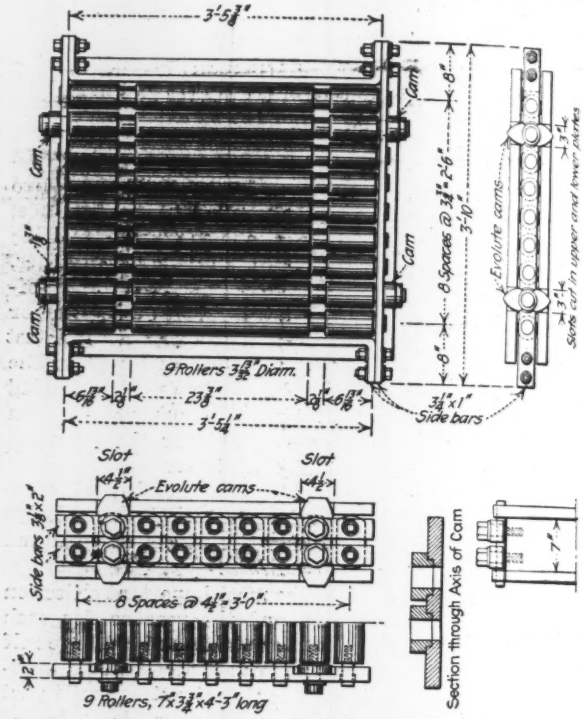


FIG. 2—FULL AND SEGMENTAL ROLLER BEARINGS WITH CONTROLLER

span were then jacked up just sufficiently to release the old rollers, and the new rollers, roller frame and cams placed in position.

Fig. 2 also shows the method adapted to the control of segmental rollers, which if allowed to rotate beyond the permissible angle give considerable trouble. In cases where the rollers are in sufficiently good condition to be used again, and where the displacement is not excessive, the controlling device can be installed without the necessity of jacking up the steelwork. The work involved in that case would comprise merely the cutting of the slots with which the operating cams engage in the edges of the upper and lower bearing plates, and the provision of new side bars, trunnions and cams. The sizes of the cams and slots are adjustable to the range of travel required. After installation, moreover, the mechanism is readily accessible for inspection.

Patent rights have been issued to the author in Canada, and have been applied for in the United States.

Abandonment of Branch Lines Denied

The Northern Pacific Railway Co. has had its application for authority to abandon two of its branch lines denied by the Interstate Commerce Commission. One branch, known as the Red Mountain Branch, extends from Helena to Rimini, a distance of 15.76 miles, all in Lewis and Clark County, Montana. The other branch, known as the Marysville branch, extends from Clough Junction to Marysville, Mont., a distance of 12.57 miles.

Construction Methods on Wide Park-Road Paving

Special Crown Profile Developed—Subgrade Specially Compacted—Center Joint In Concrete Base

BY LE ROY DANGREMOND
Civil Engineer, Chicago, Ill.

UNUSUAL widths of pavement have been constructed in recent park road work in Chicago. A new boulevard in Grant Park, between the Field Museum and Monroe St., varies from 50 ft. at Monroe St. to 100 ft. at Congress St., where the main entrance of the park will be. In front of the new Field Museum the drive is 90 ft. wide. The various widths are 50 ft., 70 ft., 90 ft., 95 ft. and 100 ft. This variation is all in accordance with the general plans of Grant Park and the boulevard system adopted for it.

Because of the excessive widths of the drive, a special form for the crown was worked out and adopted. The ordinary parabolic crown was thought to be too flat at the center of the road, thereby allowing water to stand there, and a crown of the form of two planes meeting at the center and running straight to the gutter was objectionable because of the uncomfortable riding position it would put automobiles in. The crown adopted consists of dividing the half width of the drive into three parts and dropping the pavement $\frac{3}{12}$, $\frac{7}{12}$ and $\frac{12}{12}$ respectively from the center to the gutter, the fraction being that part of the total crown at the catchbasin or any intermediate point. A 4-in. drop was given the gutters from the summit, or midpoint between

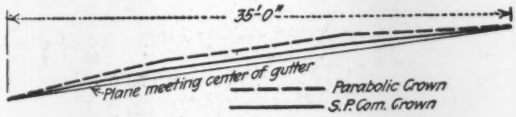


FIG. 1—COMPARISON OF PAVEMENT CROWNS FOR PARK ROAD, CHICAGO

catchbasins, to the catchbasins. Fig. 1 compares the South Park crown with those of the parabola and of two planes. It will be seen that it is nearly half way between the two, allowing the water to run off from the center, but not making the cars tilt over quite as much as a plane would.

The crowns given the various widths are 12 in. for the 50-ft. width, 14 in. for the 70-ft. width and 16 in. for the 90-ft., 95-ft. and 100-ft. widths, at the catchbasins.

Subgrade Construction—The subgrade upon which the pavement was laid is "made land." Under the place where the road is, the material dumped was to a certain extent selected, only cinders, brickbats and broken bits of concrete were allowed to be dumped. Effort was made to keep out clay and other earthy and decaying matter. To assist the elements in packing down the fill a temporary road was made over it and all the trucks coming into Grant Park, for a certain period of time, were made to go over this road. Care was taken to fill any hole or soft spot that appeared anywhere. In the summer of 1922 this subgrade was brought up to level; finished pavement elevation is 22.5 ft. and 31.5 ft. above city datum, the higher elevation being in front of the Field Museum.

An idea as to how well the subgrade was packed may be had from the experience of the party driving the grade stakes. Ordinarily wooden stakes could not be used. The points would be turned up as if driven into a cement slab. Steel pins $\frac{3}{4}$ in. in diameter and 16 in. long were used and had to be driven with a 16-lb. sledge hammer. Great care had to be used or the steel pins would bend over. The "Great Ringling Brothers and Barnum & Bailey Circus" used the subgrade in July, 1923, and all their wagons and trucks didn't even rut the road.

The preparation of the subgrade for the concrete base was done by the South Park Commissioners by the day labor system, South Park laborers doing the work under the supervision of W. G. Evans, assistant engineer. No attempt to keep an account of cost per square yard was made.

Gutter Construction—The gutter consists of a rectangular strip of concrete 8 in. high and 18 in. wide.

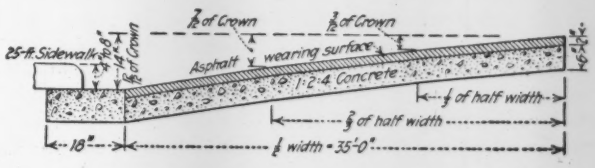


FIG. 2—SECTION OF WIDE PAVEMENT FOR PARK ROAD, CHICAGO

The sidewalk is laid 8 in. onto the gutter leaving a 10-in. gutter and the edge of the walk forming the curb. The gutter was laid ahead of the concrete base and formed side forms for the base when it was laid. The gutter consists of a 1:2:4 mixture and was surfaced or finished off with 1 in. of 1:2 mortar. There were 25 and 30 men in the gutter gang, and about 800 ft. of gutter was laid per day. August Skoglund of Chicago was the contractor.

Concrete Base Construction—After the subgrade had been leveled off and brought to shape, that of the crown adopted, the concrete base was poured. The base consists of 6 in. of 1:2:4 concrete placed on the subgrade with no attempt at tamping or roughing it, being just shoveled into place. A steel joint strip was placed in the base on the center line, throughout the length of the pavement. It consisted of No. 18 gage steel and was $5\frac{1}{2}$ in. wide and rolled with a V-shaped groove from end to end. These strips were anchored or supported by $\frac{1}{4}$-in. steel pins driven through the sides of the V and the holes were approximately 3 ft. 6 in. apart. One-half inch horizontal dowel bars, 4 ft. long, were used to bond the two sides of the pavement together. These were spaced 5 ft. apart. These bars consisted of deformed steel, the same as that used for concrete reinforcing.

The contractor used a 1-cu.yd. portable mixer placed at the side of the road and the base was laid by using $\frac{3}{4}$ cu.yd. Ford dump trucks to carry the concrete to the subgrade, the longest haul being about 800 ft. on each side of the mixer. The base was laid, sometimes by pouring one-half of the street at a time for 200 or 300 ft. and at other times by pouring the full width at once. At night no header was used. Instead, the concrete was allowed to slump or settle on the edge and the edge was sliced off and thrown back. It was tried to keep the edge as vertical as possible. In the

morning the fresh concrete was poured on top of the old, after some dry cement had first been sprinkled on the edge to make it bond better. Four Ford trucks were used to pour the base, with 47 men loading the mixer and spreading the wet concrete. This gang consisted of: 1 foreman; 2 receivers (1 at the railroad yards, 1 at job); 3 engineers (station); 1 hoisting engineer; 8 chauffeurs (for 8 Ford dump trucks); 24 men (including eight spreading concrete) and 2 watchmen.

Labor trouble forced the contractor to purchase and use two automatic loaders to load the mixer, with the help of 3 Ford dump trucks. The sand and gravel were loaded into a measuring hopper on the loader and in turn dumped into the trucks which dumped the load into the scoop of the mixer. One truck was used for sand and two for gravel. With this method of loading two trucks were used to pour the base. In addition to the saving of about 14 laborers these loaders speeded up the operation so that an average of over 400 sq.yd. of pavement per day more was laid. The average for hand loading was about 1,800 sq.yd. per day and with machine loading it was over 2,250 sq.yd. per day, 2,260 sq.yd. to be exact.

Asphalt Wearing Surface—The wearing surface is of 55 per cent crushed stone, 38 per cent sand and mineral dust and 7 per cent asphalt, all by weight. It was mixed at the 49th St. plant of the contractor and was delivered to the job in 7-ton trucks, each carrying eight one-ton boxes of asphalt, making a load of 15 tons altogether. These trucks ran over the concrete base to the point of working and were turned and backed up to where the material was required. No cracks resulted from this use of the base. At the point of working the truck bodies were hoisted and a small pile of the asphalt allowed to dump. At a signal from the foreman of the spreader gang the truck pulled forward a few feet and dumped another small pile. This was continued until the load was dumped.

The asphalt was spread with common garden rakes and rolled with tandem rollers, 7½ tons in weight. The rolling was done cross-wise first and then longitudinally until the surface was even and smooth. Along the gutter and around manholes the compression was secured by the use of hot iron tampers. The average number of square yards per day laid was 4,400, with a gang of 43 men, as follows: 1 foreman, 3 rollers, 2 watchmen, 7 rakers, 4 tampers, 3 smoothers, 23 laborers; also two chauffeurs for two Ford dump trucks.

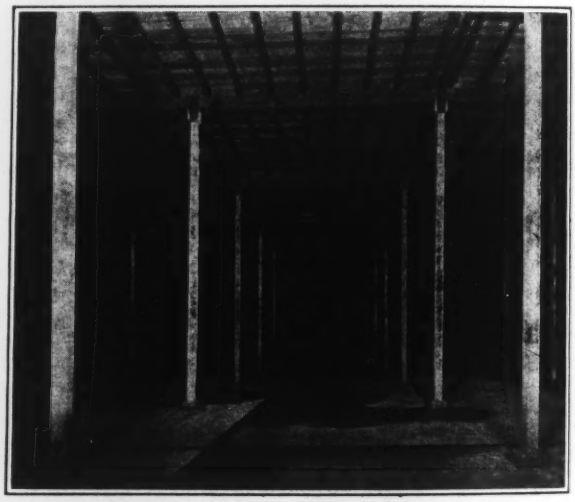
As soon as possible after the rolling of the mixture was finished and while the surface was still fresh and clean a skin coat of pure asphalt cement was spread over the surface and evenly spread with rubber squeegees. Over this, a top dressing of dry red granite chips from ¼ in. to ½ in. in size was immediately spread and thoroughly rolled. About 28 sq.yd. of surface was covered by 1-cu.yd. of chips.

At night when the work on the top was suspended the material was rolled down to a thin feather edge, a night joint-cloth was laid on the edge and rolled into the material, producing parallel grooves running across the road. This joint-cloth was a strip of 12-oz. canvas 16 in. wide having four ropes sewed on one face about 4 in. apart, the top rope being 1 in. in diameter and the other three being ¾ in. in diameter. When the paving was resumed in the morning this cloth was removed and the surface was prepared for the joint by painting with neat asphalt cement. Hot paving material was raked over it and thoroughly rolled. The faces of the curb and iron frames of handholes and catchbasins were painted with neat asphalt cement before the paving was laid.

The contractor for the pavement was R. F. Conway Co. of Chicago. The writer is indebted to A. J. Olson and Charles O'Conner of that company for figures of quantities and number of men in gangs. Linn White is chief engineer of the South Park Commissioners and it was under his supervision that the boulevard was constructed. W. G. Evans, assistant engineer of the South Park Commissioners, was in direct charge of the work.

Concrete Posts 25 Feet Long Support Reservoir Roof

REINFORCED-concrete columns 8 in. square and ranging in length up to 25 ft. were used to support the roof of a recently constructed reservoir of the Spring Valley Water Co. at San Francisco. The posts were precast using the ordinary 1:2:4 mix, and were reinforced with four ½-in. rods, one in each corner. At the top the section was increased to 8 x 12 in. to give a larger bearing area for the 6 x 12-in. roof beams. These beams were fastened together by 1 x 8-in. scabs which served the dual purpose of scabs for the beams

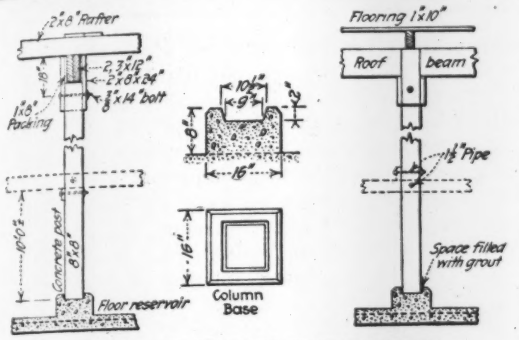


RESERVOIR INTERIOR WITH POSTS IN PLACE

and packing between the beams and the 2-ft. lengths of 2 x 8 used to connect beam and posts. The 2 x 8's were fastened to the post by a bolt passed through a ½-in. pipe placed in the post forms 6 in. from the top before the concrete was poured. The upper ends of the 2 x 8's were nailed through the scabs to the roof beams. Half-inch pipe placed in both directions through the post forms about 10 ft. from the ground end, left holes through which a temporary bracing was bolted to support the posts while the beams were being placed.

Each post was set on a concrete base 16 in. square on the outside and 8 in. high, with a square recess in the top. When the posts were lined up, grout was poured in the recess.

This construction has been successfully used in the reservoirs of the East Bay Water Co., Oakland, Calif.,



DETAILS OF COLUMN CONSTRUCTION

for several years and more recently has been adopted by the Spring Valley Co. for reservoirs of a certain class.

Architect and Engineer Unite in Design of Hotel

Hotel Has Concrete Frame, Cantilever Footings and Irregular Column Spacing—Heavy Loads of Material Piled on Floors

Abstract of paper read before the Engineering Society of Wisconsin by Grover H. Lippert, of Balch & Lippert, architects, Madison, Wis.

IN DESIGNING the New Belmont Hotel at Madison, Wis., there was close co-operation between the architect and the engineer in planning a building of certain fundamental requirements and with difficult engineering problems. For utilizing a valuable site on Capitol Square, occupied by an old two-story structure, both an office building and hotel were considered, but a study of the situation showed that the former would be more or less of a speculative venture. The hotel will be 120x44 ft., with eleven stories, basement and sub-basement, this last being for the mechanical equipment. Above the first floor, each floor will have twenty rooms and there will be two elevators and two stairways. Reinforced concrete is used for the frame; exterior walls are to be faced with cut stone and face brick, backed with clay building tile; interior walls and partitions will be of gypsum blocks and clay tile.

Our first decision involved the type of construction. We, that is, the architects and the engineer, eliminated almost immediately the steel frame structure, due primarily to our past experience with concrete construction. One of the elements that influenced our decision was a fire in one of the rooms of the present Belmont addition, which is of reinforced concrete. Although the heat was intense it had no effect on the concrete members. We found that the steel skeleton frame could be erected in less time than the concrete, but the concrete would consist of framework, floors, stairs, etc., while the steel would be framework only. Numerous salesmen visited our office to present money-saving devices and methods of concrete construction. They all had engineers who would be only too willing to furnish us with a structural design, free of charge. This outgrowth of the competitive system of selling is a dangerous condition, especially to the engineer and the engineering profession.

We decided to use the simple reinforced-concrete column and girder construction, with concrete joists and metal tile for floors. The metal tile is of heavy corrugated metal and stands on a pressed steel base, total weight over 7 lb. to the tile. The usual tile weighs about three or four pounds. This base forms the plastering base and is of sufficient strength to allow the plasterer to apply his material without pushing the metal out of place or the sagging of the metal between joists. It allows us to use two-coat plastering instead of three-coat as required by a metal-lath base, while its strength allows us to make considerable saving in other branches. We can set the tile and base for one entire floor of this building in about four hours' time. This is important, because according to union regulations no one but lathers can set the metal base for tile, at $1 an hour; the tile we selected can be set by common labor.

It is almost impossible to design a symmetrical system of columns and girders in a building of this nature, because of the irregularity of room arrangement. The structural members are sure to be more or less irregular in position and this requires the absolute co-operation of the architect and the engineer. The architect must give all he can for depth of girders and size of the various members of the structure. The engineer must keep in mind that room arrangement, corridors, pipe chases and stair and elevator wells cannot be placed in any position to fit his structure. The engineer worked with us constantly and we with him; every solution had its reason and every complex problem that arose required the attention of both parties.

Our engineer did all of his calculations in our office, where he could be in close touch with the work and take care of any difficult problems as the plans progressed. After a sketch floor plan had been made, we all studied the layout for column spotting and placing of girders. Some of these locations had to be changed in the final plan due to difficulties and size of members. After the calculations were completed the architects made their steel schedule for columns, girders, footings and floor slabs, giving diagrams for size, length, shape and placement for every piece of steel. This required hours of time at the drafting board, but saved the owners $6 per ton on all the steel.

The column foundations required considerable study, being limited on one side by the property line. A system of cantilever footings was designed, some of which carried the combined load of four to six columns. We used a soil pressure of 5,000 lb. per square foot. The total load of the building on the soil amounts to 14,377,000 lb., including the live and dead-loads and also wind pressure.

Our reinforced concrete design is based on the working stress of 620 lb. per square inch in the concrete and 16,000 lb. in the steel. All unit stresses are equal to or less than prescribed by the Joint Committee for 1:2:4 concrete of 2,000 lb. ultimate strength. The beams and girders were calculated somewhat in excess of the minimum requirements, but it is to be considered that partition spacing is subject to revision and that loads are of a variable nature. In certain cases the size of concrete members might have been reduced somewhat by using maximum shear stresses for full web reinforcement. The necessity of using many stirrups was avoided by keeping the total unit shear at about 70 to 80 lb. per square inch. In many cases also headroom requirements necessitated girders of comparatively greater breadth. Web reinforcement or stirrups were calculated to carry two-thirds of the total shear.

Most of the columns support girders of unsymmetrical spans. The columns are designed to bear the full axial loads of the building and to resist bending moments due to unequal girder spans and to eccentric loads. Consideration of the large moment effect which occurred was one of the factors that led to the selection of the rectangular column section, which affords a more effective arrangement of bars to resist bending. The other factor was that brickwork is jointed to a column of this shape more effectively and with less labor.

We have been favored with criticism by some engineers and contractors pertaining to what they call "excessive use of steel and concrete." We are more than satisfied that the design is safe and conservative and structurally adequate. To indicate why we take this attitude, let me give you some of the unlooked-for things that might happen during the construction of any building through carelessness of mechanics. One day we found that the plasterer had unloaded three or four wagon loads of plaster and stacked it in the center of a floor slab. Upon figuring up the load we found it to average about 400 lb. per square foot. Some days later mechanics were lowering along a sloping runway into the sub-basement a large metal tank weighing about 6,000 lb., with a chain and tackle fastened about the center of one of the floor girders. The tank got out of control and swung by the chain, but the girder held the load.

Most of our concrete has been poured during very cold weather, due to a time limit for the completion of this building. This has made it necessary to take extra precautions to protect the concrete from freezing and has required most careful inspection. We have used nothing but heated sand, gravel and water. A balloon canvas cover is placed over the top two stories and the one being poured, with salamanders burning on all three stories.

Court Holds Water Company Liable for Typhoid Death

Outcome of One of 31 Suits Was Jury Award of $2,000 to Widow of Typhoid Decedent in Borough of Walnutport, Pa.

By G. Douglas Andrews
Chief Engineer, Bureau Water-Works and Sewerage, Easton, Pa.; Formerly District Engineer, Pennsylvania Department of Health

THE AWARD of damages against a small water company in Pennsylvania should be of interest to water-works and public health officials. A jury in Northampton County, Pa., on Oct. 11, 1923, returned a verdict in the sum of $2,000 in favor of a plaintiff who brought suit against the Blue Ridge Water Supply Co., of Walnutport, charging it with negligence in the protection of its sources of supply, and alleging that in June, 1921, the company had served to the public a contaminated water which caused the death of the husband of the plaintiff from typhoid fever. This was one of 56 cases of typhoid in a residential community of 1,000 population, and the lawsuit was one of 31 brought against the company. In the five suits set for trial in April the water company has permitted judgments to be entered against it without trial. It is likely that this will be done in the remaining cases.

The Blue Ridge Water Supply Co. was incorporated under the laws of Pennsylvania in 1902 and was chartered to supply water to the public in the borough of Walnutport. In 1905, the General Assembly of Pennsylvania passed an act requiring, among other things, every municipality and company supplying water to the public to file plans of their works with the State Health Department and to secure permits before introducing an additional supply. In general the law was complied with but there were a few concerns, mostly small ones, which did not do so, and in some instances their existence was not discovered until the Department of Health engineers undertook intensive investigations to secure data concerning all public water supplies within the commonwealth.

The Blue Ridge Water Supply Co. was in this class, which fact was disclosed in September, 1920, when the Health Department found that the borough of Walnutport had a public water supply and that the water company in question had never filed the required plans.

Source of Supply — An immediate investigation showed that the company derived its supply from springs located at the base of the Blue Mountains, the water being collected in two earth reservoirs with a combined capacity of 1.8 m.g. These reservoirs are some two miles north of the borough and about one-fourth mile apart, and from them the water flows by gravity into the distribution system. The upper or older reservoir is fed by two springs in its bottom. The lower reservoir, the one most recently built, is supplied by two nearby springs. They were partly enclosed with masonry walls and the water flowed from each spring through a board-covered ditch to a single small collecting basin from which it was piped to the reservoir.

The company was instructed to remove algae from both reservoirs, repair the spring enclosures at the lower reservoir, place wood covers over the springs and protect the collecting ditches. A reinspection made in February, 1921, showed that the algae had been removed from the reservoirs, but improvements had not been effected to the springs at the lower reservoir. A letter from the company dated April 23, 1921, advised the Health Department that the reservoirs had been cleaned and the surroundings improved.

This was the situation on June 22, 1921, when the Health Department learned through the public press of a typhoid outbreak in Walnutport. Engineers were at once sent to the town, followed a little later by physicians and nurses, and steps were taken to combat the disease. All told, there were 56 cases of typhoid fever having dates of onset within a ten-day period.

Analysis of data obtained by a case-to-case canvass threw strong suspicion on the public water supply as being the cause of the outbreak. An investigation of the water-works system indicated that the lower reservoir supply had been cut out of the system early in the spring of 1921 to permit cleaning the basin and the making of other improvements. Meanwhile the upper reservoir was relied upon for the water supply of the town and it was in service at the time of the outbreak. It was ascertained that a breach had been made in the earth wall of the upper reservoir through which the water from a surface stream nearby entered the enclosure. An inspection of the watershed of the stream above this point disclosed habitations where there were insanitary conditions existing, and also the fact that a public highway traversed the catchment area. A principal tributary to the stream was fed by a large unprotected spring situated only a few feet from this highway.

Acting under instructions of the Health Department representatives the upper reservoir supply was turned off and a chlorination plant installed at the lower reservoir. Bacterial examination of numerous samples indicated contamination of the supply from the upper reservoir.

Liability of Water Company—Following this outbreak of typhoid fever, 31 separate suits were filed in the County Court against the Blue Ridge Water Supply Co., seeking damages aggregating about $290,000. One case was brought to trial on Oct. 8, 1923, the plaintiff being the widow of a man who, it was alleged, contracted typhoid fever from the public water supply and died of the disease. The witnesses for the plaintiff included the widow herself, the attending physician, a property owner on the surface stream which was diverted into the upper reservoir, and Department of Health representatives, including the county medical director and engineers.

At the beginning of the trial the court ruled that the case would have to be tried on its own merits and not on the basis of the epidemic. The plaintiff's testimony was to the effect that the decedent had on numerous occasions complained to her of the poor quality of the water furnished by the defendant company, saying that it was "rotten and unfit to drink and tasted like manure smelt." Considerable stress was laid on this statement by the defendant's attorney, who endeavored to show that there was contributory negligence on the part of the decedent if he continued to drink this water if it was in that condition.

Evidence was introduced with the intent of showing that the illness was due to the use of a contaminated

water supply furnished by the Blue Ridge Water Supply Co. This contention was supported by the facts that all other probable sources of infection were eliminated except the public water supply; that it was a surface supply draining an inhabited watershed and having thereon potential menaces to its purity; and that analyses of samples of water secured from the public supply showed evidence of its contamination. The point was made by the defendant's attorney that the decedent, while away from home, had used water from public supplies in neighboring municipalities. It was shown that the Department of Health had knowledge of these public supplies and there was no suspicion of their being contaminated.

In his charge to the jury the judge stated that the first question to be considered was whether or not the defendant company had been negligible, and if not, a verdict of acquittal should be rendered; if they, the jury, found that the defendant company was guilty of negligence, then they should decide whether or not there was any contributory negligence on the part of the decedent; then, if the jury found there was not any such negligence on the part of the decedent, they were to determine by the evidence produced by the experts whether or not the cause of the decedent's illness and death was from the use of the water supplied by the Blue Ridge Water Supply Co. on or before June 14, 1921.

The jury returned a verdict in favor of the plaintiff and awarded her $2,000 damages.

Relative Merit of Reduced Grades and Heavier Locomotives

Abstract of report of committee on Economics of Railway Location, presented at the annual meeting of the American Railway Engineering Association.

A DEFINITE procedure for testing the economic justification for contemplated grade reduction is incorporated in the "Manual" but the constant necessity for increased traffic capacity has resulted in larger locomotives for the existing grades. In general, they are fully justified by the fact that they have been and are now hauling a volume of traffic that the railroads could not otherwise handle. Whether they have tended to increase or decrease the operating ratio is not susceptible of easy analysis, since they have involved increased capital charges in the structures to carry them and increased repairs to equipment to set against decreased train mileage per ton-mile.

Grade reductions are permanent improvements. When completed and charged to capital account they do not involve any increased expenses for maintenance-of-way and structures. In fact, they usually result in a decrease in such expenses after the seasoning period, because in their construction they afford the opportunity of eliminating grade crossings, replacing wooden and steel bridges with concrete structures or solid embankments, and following the latest approved practices in such important matters as drainage. They do not affect maintenance of equipment, as no change in power is required and there is no increase in the train resistance, although more cars are hauled per train.

Grade reductions require considerable periods to construct, during which time operation on the old line may be greatly hampered by the construction work. They also serve only limited parts of the railroad systems. In the case of some of the older systems formed by linking up short lines built without regard for the needs of through traffic, grade-reduction programs under way for many years still leave the systems with sections of ruling grade out of harmony with the systems as a whole.

Heavier power is immediate in its results and is flexible. It can be ordered in one or a hundred units as the situation requires, and these units can be shifted to any division whose bridges and roadbed will sustain them, replacing or supplementing overnight the lighter power in use. Before the heavier units can be used, however, there may be necessary a reconstruction period comparable in length to that required for a grade reduction, to bring the bridges and roadway up to the weight capacity to carry the heavier units; to provide longer stalls in engine houses, longer turntables and ashpits, additional shop machinery and more powerful cranes to serve and facilitate repairs to the larger units; to lengthen sidings and yard tracks to hold the longer trains they will haul. All of these items are capital charges and must be taken into account in an economic comparison with the alternative of a grade reduction.

Since the heavier locomotive hauls a longer train by exerting a greater tractive effort and overcoming a greater train resistance, the cars must be stronger or the repair bills will mount. The building of stronger cars and the strengthening of old ones has been going on steadily, but as there is always a large percentage of cars not yet brought up to recent strength standards, and these cars move throughout the country in interchange business, they are inevitably subjected to the large resistances imposed by the heavy locomotives. Heavy power has added materially to the cost per ton-mile of maintenance of equipment and maintenance-of-way and structures. Other elements to be considered are the relative capital charges and amounts of depreciation per pound of tractive power of heavy locomotives and lighter ones.

From the standpoint that each locomotive in freight-line haul should be working at all times to substantially its full capacity, grade reductions, which tend to make the train resistance uniform throughout the division, seem sounder in principle than the introduction of heavier locomotives, which by main strength haul longer trains over the limiting grades, but on the rest of the division are working to no higher percentage of their capacity than the lighter locomotives.

The time element, however, is an important consideration. If the limiting grade occurs only at a few points, the locomotive will have surplus power elsewhere to accelerate the train, and may be able to get the train over the division without overtime, whereas with a uniform grade and the locomotive loaded to capacity it may be impossible to make necessary speed. A division might have one five-mile grade up which a locomotive could haul at five miles per hour the train it would haul the rest of the distance at 15 m.p.h. Reducing this grade to the average of the others would cut the running time for the same train but forty minutes, and the possible increase in train tonnage without increased running time would be slight. The time element is especially serious because so many division points and engine runs have been located with a view to a longer working day than the present standard. Any additional overtime involved in grade reductions which utilize the full capacity of the locomotive should be weighed against the saving in train-miles per ton-mile.

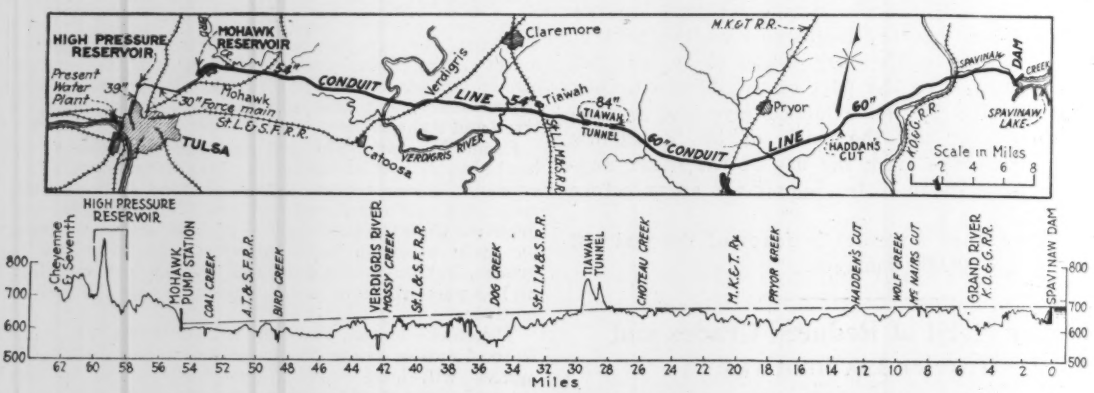
The possibilities of momentum grades and pusher grades are set forth in the "Manual." Locomotive "boosters" built either as small steam engines geared to the axle of the trailing truck or as small four-wheel tractors replacing one or both of the tender trucks in order to utilize these additional wheel-loads to add to the adhesion and tractive effort of the locomotive, appear to occupy a position somewhat intermediate to the momentum grade and the pusher grade. The booster has its chief use in assisting in accelerating or in surmounting short ruling grades, where it is impossible or unsafe to depend on momentum but where the use of pushers is economically unjustified. The booster is designed to operate only at low locomotive speeds, and cannot be regarded as a substitute for a heavier locomotive for general road work.

Momentum grades, pusher grades and the use of the booster are all factors to be considered in a contemplated grade reduction. Grade reductions are not necessarily alternatives to the introduction of heavier power; they may well supplement and complement each other.

Spavinaw Water Supply Project for Tulsa, Oklahoma

Fifty-Five-Mile Gravity Conduit Brings Ozark Supply to Reservoir Lower Than City—Pumps Lift to High Service Reservoir

DUE TO AN unusually rapid growth in the last ten years, Tulsa, Okla., is face to face with grave municipal problems, chief among which is her source of water supply. Up to the present time, the city has used the Arkansas River, one of the most turbid, most unpalatable and hardest waters in the Southwest. Although a modern, well-equipped filter plant was built in 1918 (see *Engineering News-Record*, Nov. 3, 1921, p. 719, and Aug. 1, 1918, p. 221), it cannot remove the high salt content of the water, 300 to 3,000 p.p.m., and make it palatable for drinking. The citizens depend on well water, retailed at 5c. a gallon, for drinking purposes, at an annual expense of from $300,000 to $500,000. The streams of the Ozark Mountains, near the border line between Oklahoma and Arkansas, are soft and clear, ideal for industrial and domestic uses, but they are 60 miles away, pipe-line distance.



MAP AND PROFILE OF SPAVINAW WATER PROJECT FOR TULSA, OKLA.

After surveys and reports by various consulting engineers, the Spavinaw River in the Ozarks was declared to be the nearest logical source. This stream is fed largely by springs, carries a clear and soft water, drains an area of 400 sq. miles, and has a minimum flow of 17 m.g.d. In 1921, after the city had voted a bond issue of $25,000 to cover the expense, a survey was made to determine a feasible conduit line and the reservoir sites. Upon the report of this survey, which promised that the water could be brought close to the city by gravity alone, the city voted in November, 1921, a bond issue of $6,800,000. Final surveys were made and plans and specifications were prepared during the summer of 1922, and contracts for the main part of the work were let in October, 1922. Eighteen months ending April, 1924, is the contract period for the conduit, the portion of the project requiring the longest time. Though an unusually short contract period for such a large project, the exigencies of the situation demanded that Tulsa should have good water as soon as humanly possible.

The main features of the project are the dam on Spavinaw Creek, near the old Indian village of Spavinaw, which will be 55 ft. in maximum height, 3,500 ft. long including the earth portion, and impound 18,000 m.g. of water; a conduit of precast, reinforced-concrete pipe, 60 and 54 in. in diameter and 53½ miles long, with capacity of 25 m.g.d.; Tiawah tunnel and approaches, midway of this conduit line, an 84-in. horseshoe section 10,000 ft. long, tunneling a ridge near Pryor; at the end of the conduit and 5 miles northeast or Tulsa, Mohawk reservoir, with a storage capacity of 500 m.g.d.; a pumping station at Mohawk, equipped with two 12-m.g.d. turbine-driven pumps; a 30-in. steel force main 4 miles long, with a rise of 275 ft., delivering into a 10-m.g. high service reservoir from which the water will flow directly to the city by gravity through a 39-in. cast-iron main. This last reservoir is a covered, circular, concrete reservoir, with gunite bottom. The water is lifted 275 ft. and pumped into the high service reservoir from the earth reservoir at Mohawk.

Flow through the 54 miles of concrete conduit and the intervening tunnel by gravity alone is the main feat of the project. It was made possible by the fact that the Bird Creek Valley in which the Mohawk reservoir is located is 50 ft. lower than the banks of the Arkansas River on which the city is built.

This 50 ft. together with the 50 ft. height of the dam at Spavinaw gives the essential head. The long stretch of connecting conduit from the mountains to the city has unusual interest in that it crosses five railroads and passes under two large rivers, the Grand and the Verdigris, by inverted siphons. It is located

PRICES ON SIXTEEN CONTRACTS

Telephone line, 60 miles	$11,606
Clearing dam site, 900 acres @ 22.50	20,250
Spavinaw dam (chief item 80,420 yd. concrete)	787,610
60-in. conduit (including manufacture and laying 147,600 lin.ft. of precast, reinforced, concrete pipe)	2,136,980
Tiawah tunnel and approaches	304,057
54-in. conduit (including the manufacture and laying of 129,800 lin.ft. of 54-in. precast, reinforced-concrete pipe)	1,715,160
Mohawk reservoir (chief item 300,000 cu.yd. earth embankment)	105,956
Furnishing 4,000 tons of 39, 36, and 20-in. cast-iron pipe	210,792
Furnishing valves	7,574
Laying 10,000 ft. cast-iron pipe	49,358
Covered concrete reservoir, gunite floor, (4,100 cu.yd. concrete; 64,700 sq.ft. gunite, 3 in. thick)	150,574
Two 12-m.g.d. turbine-driven pumps for the Mohawk station	83,400
Two 350-hp. boilers for the Mohawk station	23,000
Mohawk pumping station (including power house, aerator, receiving well and piping)	220,000
150-ft. concrete smokestack	4,984
Four miles 30-in. riveted-steel pipe, placed in the ground	230,263
Total amount of the contracts as let	$6,061,524

in a comparatively inaccessible and sparsely settled country, making the chief problem of the whole project the distribution of the pipe. To facilitate this work, a standard-gage railroad was built along the whole line of the conduit, with a telephone line parallel. Instead of several pipe plants along the line, delivery of the raw materials seemed to determine that one large plant should be located at Verdigris, on the Frisco R.R., about 14 miles east of Mohawk. All the pipe is distributed from this plant on flat cars, three lengths to a car, in either direction on the conduit line.

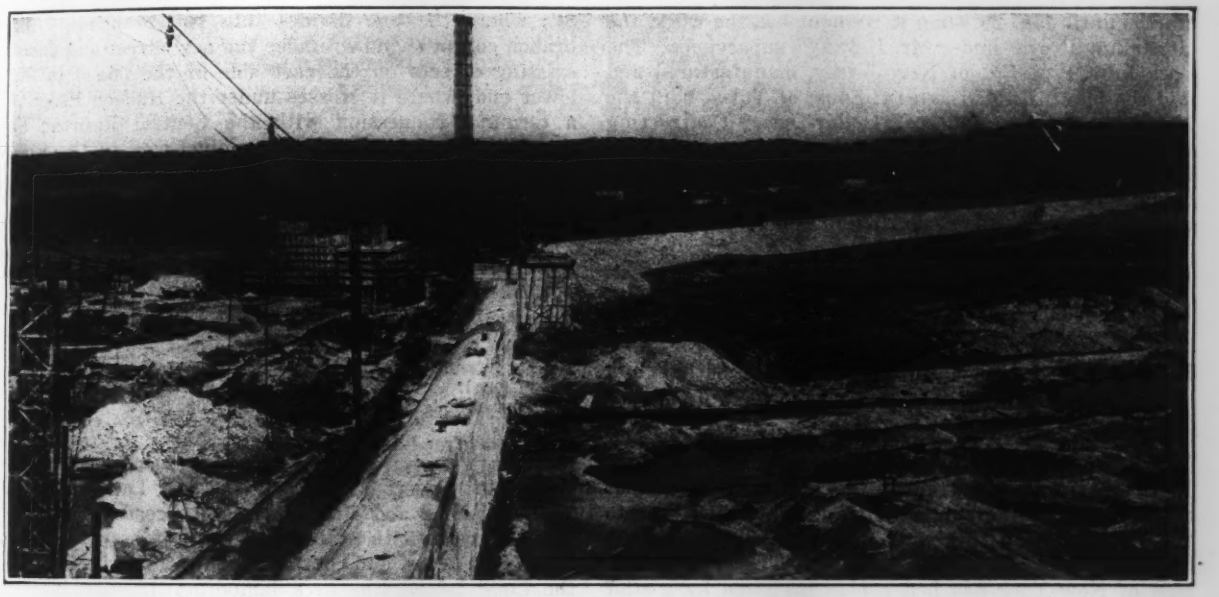
The pipe plant consists of four units, with a total capacity of 96 lengths per day, 48 of 54-in. and 48 of 60-in. Each pipe weighs 6 tons. These lengths are reinforced vertically and longitudinally for different pressures due to the difference in elevation of the pipe below the hydraulic gradient. At this plant is assembled the raw material consisting of crushed limestone, Arkansas River sand and cement, all handled in the yards by locomotive cranes. The pipe is hauled over the Spavinaw R.R. according to a carefully planned program to the location on the pipe line for which the pipe is reinforced. It is rolled off the cars and is later laid in a trench prepared by steam and gasoline shovels; the laying is done by 30-ton locomotive cranes operating on independent tracks. Each crane shifts its own track.

On March 15, thirty days sooner than the date agreed upon, the Lock Joint Pipe Co. poured the last length of reinforced-concrete pipe for the conduit from the dam to the city. The first piece of pipe on this project was made Jan. 30, 1923; approximately 53 miles of 60-in. and 54-in. pipe has been made in 13½ months, representing a value of $2,727,000. This unusual record has been made under the most adverse weather conditions of record in Oklahoma. The Lock Joint Co., which holds the contract for the manufacture and laying of the pipe, wih easily complete its part of the work well within the contract period of eighteen months. The remainder of the work on these contracts, the excavation, backfilling, building the railroad, distributing the pipe, etc., is now being handled by the city of Tulsa since the abandonment of the contract by the Walbridge-Aldinger Co. Progress by the city is such that it expects to complete the work in mid-summer. It is being handled under the direct supervision of W. R. Holway, engineer for the Water Commission.

Due to the extremely flat hydraulic gradient, deviation from a straight line was necessary to avoid excessively deep cuts and a longer tunnel. Even as finally located, the flat gradient required the use of one rock cut with a maximum depth of 22 ft. and a total length of 3,000 ft.

Tiawah Tunnel lies between the two sizes of pipe, all 60-in. to the east of it, and all 54-in. to the west, a change in size made possible by the lower ground elevation as the line approaches the city. The tunnel was designed for a capacity of 75 m.g.d., in order to provide for the construction of greater pipe capacity without the necessity of building a new tunnel. It is lined with 6 in. of concrete, and was bored through shale formation, the work being carried on from four headings.

The Spavinaw dam has a total length of 3,500 ft., including 800 ft. of concrete spillway; 150 ft. of concrete non-overflow section; and 2,550 ft. of earth embankment paved with 8 in. of concrete on gravel and provided with a concrete core-wall. The resulting 18,000-m.g. reservoir, stretching upstream for 6 miles, will be located at a natural site between two ranges of the Spavinaw hills. Preparation of the site for the reservoir involved the clearing of 1,000 acres of timber and the removal of the village of Spavinaw to a new site below the dam, purchased and laid out by the city of Tulsa. Construction of the dam was started in October, 1922, at a contract price of $787,610.



WATER SUPPLY DAM OVER SPAVINAW CREEK, OKLAHOMA, READY FOR CLOSING

Concrete gravity structure, 55 ft. high, 800 ft. long, will impound 18,000 m.g. of water 60 miles above Tulsa. Concrete handled from cableway. Two mixers at far end in screening plant and one at lower left of picture. Relocated town in background; old town out of picture at right. Quarry across river at right.

Mohawk reservoir, at the west end of the conduit, is an artificial reservoir, in earth, with concrete paved slopes. A small earth dam diverts the waters of Flat Rock Creek to make way for the reservoir in its old valley. Between Mohawk and the high service reservoir is a 30-in. steel force main. A high hill, a mile north of the city, furnished a site for the reservoir.

Preliminary surveys were made by the Holway Engineering Co., Tulsa, Okla., with J. D. Trammell of Fort Worth, Texas, and G. W. Goethals, New York City, as consultants. Messrs. Trammell and Holway prepared the plans and specifications and W. R. Holway is in active charge of construction. Dabney H. Maury of Chicago is the consulting engineer.

For the Spavinaw dam, the reservoir clearing, the tunnel and laying the cast-iron pipe the Standard Paving Co. of Tulsa is contractor. For the concrete conduit the Walbridge-Aldinger Co. of Detroit was the contractor until Jan. 29 when it relinquished the work, the city taking it over under Mr. Holway's supervision. The Lock-Joint Pipe Co., of New Jersey, manufactured and laid the pipe. R. M. Davies & Sons, of Tulsa, built the Mohawk reservoir; and the Traylor-Dewey Contracting Co., now the Cement-Gun Contracting Co., Allentown, Pa., built the concrete reservoir. The pump station is being built by E. J. Merkle, Kansas City, and the stack by the John V. Boland Construction Co., St. Louis.

Suburban Transit Plan Suggested for New York City

Independent Subway System to Connect with Trunk Line Railways Outside of Manhattan Island—New Streets Proposed

FOR HANDLING the suburban traffic of New York City as well as to relieve the existing subways of a large part of the suburban traffic which now has to use them between the trunk line terminals and points of business throughout the city, the Transit Commission of New York has had a plan prepared by a staff committee under the chairmanship of Daniel L. Turner, consulting engineer to the commission. The plan as prepared by the committee has not yet been passed upon by the Transit Commission, but has been made public by it while still in the tentative stage for the information of the public and for comment. The "Proposed Metropolitan Transit System to Serve New York and Its Environs," being interstate in character, will require, if put into effect, joint action of at least New York and New Jersey, and possibly Connecticut if the cost of construction is distributed over the whole area served, an area including part or all of nine counties in New York State, nine in New Jersey, and one in Connecticut, in all 3,766 sq.mi. of land area having a population of 8,587,000 in 1920, and an estimated population of 10,500,000 in 1930, of whom about 3,900,000 will be living in the suburbs. Therefore, even though the New York Transit Commission approves of the plan, its execution will have to be carried out by an interstate treaty similar to those setting up the Port of New York Authority and the Vehicular Tunnel Commission.

The general layout of the plan as shown in the accompanying figure consists of three separate lines or loops of double- or multiple-track lines, largely subways:

(1) A Long Island line to serve Long Island exclusively from a terminal at Jamaica, following the line of the Long Island R.R. to a terminal in Brooklyn at Flatbush Ave., under the East River to the Battery in Manhattan, thence up the west side of Manhattan Island partly under existing streets and partly under a new street to be cut between Ninth and Tenth Aves, to 57th St., thence eastward across Manhattan and under the East River to connect again with the Long Island R.R. main line, and thence to Jamaica, using the Long Island tracks. This will be a two-track line, largely subway, 19.5 miles long exclusive of the Long Island main line, costing approximately $152,000,000.

(2) A Westchester-New Jersey line to serve both Westchester and Connecticut territory as well as New Jersey, starting from 149th St. in the Bronx, extending down the east side of Manhattan under a new street to be located between Third and Second Aves., to 58th St., where the line divides into two branches. One branch continues down under the new street and under existing streets on the east side of the island to the lower end, where it crosses under the Hudson River to a terminal connection with the Central Railroad of New Jersey, and thence to a terminal west of the Palisades ridge in the neighborhood of West Side and Sip Aves.; to connect with the Delaware, Lackawanna & Western, Erie and Pennsylvania Railroads; the other branch crosses 58th St. to the new street between Ninth and Tenth Aves. and continues along the same route as the Long Island line to a temporary terminal at the Battery; in the future it may be extended to Brooklyn and Jamaica or to New Jersey. This line will be four-tracked from the Bronx to 58th St. and the branches will be double-track. It will be 19.9 miles long and will cost approximately $180,000,000.

PROPOSED DISTRIBUTION OF COST, NEW YORK SUBURBAN TRANSIT

Beneficiary	Total	Amount per Year for 8 Years
State of New York	$36,900,000	$4,600,000
State of New Jersey	48,400,000	6,000,000
19 Counties	278,700,000	34,900,000
Total	$364,000,000	$45,500,000
17 Railroads	138,000,000	.....
Grand total	$502,000,000	$45,500,000

(3) A New Jersey line to serve New Jersey exclusively starting from the terminal at West Side and Sip Aves. in Jersey City and following the route of the Westchester-New Jersey line across under the Hudson to the Battery and up the east side of Manhattan to 57th St., where it turns westward across 57th St. and under the Hudson River to Weehawken, thence through a tunnel under the Palisades to a terminal for West Shore, Erie, and Susquehanna & Western trains, thence south along the Meadows to the terminal at West Side and Sip Aves. This line will be double-track, 17.4 miles long, and will cost approximately $220,000,000.

Trains will enter both legs of the Long Island loop at Jamaica, thus providing direct access to the mid-town section of Manhattan for commuters wishing to go there. One track of the New Jersey loop crossing the Hudson at 57th St. will give similar service to New Jersey commuters; the other track will supplement the two tracks of the Westchester-New Jersey line into lower Manhattan.

Financial Plan—In view of the fact that there will be many direct beneficiaries from the system apart from the passengers who use it daily, the plan calls for distributing the cost over the two states, 19 counties, and 17 railroads, and provides that the money to construct the project shall, in a large part, be provided under an eight-year annual assessment or tax plan. The proposed distribution of cost is indicated in the table on page 818.

The committee points out that if the project is financed in the usual way by the issue of 25-year bonds, the total cost, including interest and sinking fund charges to the end of a 25-year amortization period, would amount to $966,000,000. Of this sum $480,000,000 would be spent for the use of money, whereas under the eight-year plan only $120,000,000 will be used for this purpose.

The figure for the total cost does not include equipment. At the outset those railroads that are not yet electrified will have to use electric locomotives to haul their trains through the system, but eventually it is expected the operation will consist entirely of motor-car operation. The equipment, including line equipment, power and transmission, yards, repair shops and cars, is approximately to cost $185,000,000. This will bring the total cost of the system up to $687,000,000. The suburban passengers using the system will only be required to pay for the cost of the service and the interest and sinking fund charges on $323,000,000. The remainder of the cost, $364,000,000, will represent the money to be collected from the state, county, and city under the eight-year annual assessment or tax plan.

The system is to be a bi-state project, owned by the states of New York and New Jersey, and leased to a terminal operating company. The railroads sharing in the cost will have an equity in the system represented by their contributions to the cost. All the remaining equity will vest in the two states.

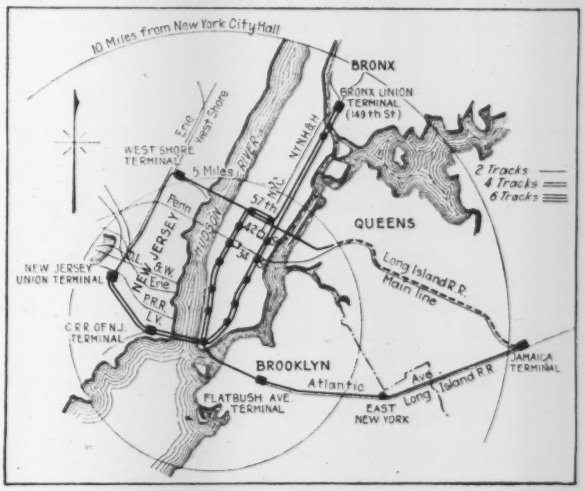
Method of Operation—During the rush hours particularly, and all day long on lines that have sufficient traffic to justify it, through service will be provided for the trains of all railroads, so that all suburban passengers may be carried to their destinations in the business district of Manhattan without change of cars. During the non-rush hours, most of the suburban passengers will have to transfer at the distant terminals. An all-day train service at frequent intervals will be operated over each line of the system from terminal to terminal for the accommodation of this non-rush hour service.

Service—The train and car capacity of a one-way movement is as follows, the trains being operated on a 2-minute headway:

Sector	Number of Tracks	Number of Trains, 35 Trains per Track	Number of Cars, 10 Cars per Train
Long Island	2	70	700
Westchester	2	70	700
New Jersey	3	105	1,050
Total	7	245	2,450

This service conforms closely to the service now being provided in each of the several sectors. For example, the system provides for the Long Island, Westchester and New Jersey sectors respectively, 70, 70, and 105 trains in and out of the city morning and night, whereas the present train service within the suburban area and in and out of the city for the several sectors is respectively 65, 42, and 109 trains during the maximum hour of service. In the existing service the average number of cars per train is under 8. It is estimated that during the maximum hour about 1,850 cars now reach the city on all of the roads serving the metropolitan transit district. The metropolitan transit system, therefore, will be capable of providing 600 more cars per hour than are now provided on all of the steam railroad suburban services entering the city. If 72-seat cars are used (present type with center door added) 176,400 seated passengers can be carried in one direction into the city in the morning and out of the city at night. If a 100-seat car can be developed, the capacity will become 245,000 seated passengers in one direction during rush hours.

At the present time the maximum commuter fare within the metropolitan transit district is about 35c. each way. On the basis of 400,000,000 passengers being carried per year, it has been roughly estimated that the fare on the metropolitan transit system would have to be about 10c. per ride to cover operating expenses and the fixed charges that the eight-year assessment or tax plan would require. But if the cost must be



LAYOUT OF NEW YORK SUBURBAN TRANSIT PLAN

financed entirely under the usual long-term bond plan, the fare would have to be about 18c. It is possible that after the system has been inaugurated there will be some reduction in the existing commuter fares which will offset the increased cost of the service.

Stations—The system will include five outer terminal stations, one in Long Island, one in the Bronx, and the other three in New Jersey, which will be a combination of through terminals and transfer stations. These stations will, on account of the necessary transferring, contain probably three or four station tracks to each main track. In Manhattan there will be stations at the usual intervals corresponding to the express stops of the existing subways, and on Long Island there will be stations at East New York, Flatbush Ave. (in Brooklyn), and Long Island City (in Queens). In New Jersey there will be three or four stations distributed along the line between the Central Railroad of New Jersey and the West Shore terminal. One of these stations will be an important one as it will serve as a union transfer point to the main lines of the Lackawanna,

Erie, and Pennsylvania Railroads, so as to permit passengers to reach the existing terminals of these railroads in Jersey City at the water front.

In order to serve the maximum number of passengers and to obtain the greatest possible financial return, the stations will be arranged to permit the closest operating headway. To this end, it is proposed that all Manhattan stations be built on the reservoir principle, that is, constructed with two tracks—one on each side of an island platform—for each main line track so that trains approaching the station instead of waiting for the preceding train can run in at the opposite side of the platform to discharge.

Altogether, including the outer terminals, there will probably be 26 stations on the system.

Proposed New Streets—Incidental to the construction of the system, it is proposed to develop two new streets 120 ft. wide consisting of an upper level for automobile express traffic, a lower level for commercial traffic, and the new subways below street grade. The streets will be located between Second and Third Aves. on the east side from Houston St. to the Harlem River, and between Ninth and Tenth Aves. on the west side from 14th St. to 68th St. It is estimated that these two streets will add 36 lanes of traffic to the existing 86 north and south lanes in Manhattan, and will thus increase the existing street capacity north and south 42 per cent. The cost of the real estate for the new street is to be divided between the subways and the new streets, so that the streets with their share of the real estate cost will cost approximately $47,000,000. The advantage to be gained by opening new streets is that the subways can be excavated by open-cut methods at a considerable saving over the cost of excavating them under existing streets or in deep rock tunnels. But if the opening of new streets is considered inadvisable, the system could be carried as deep rock tunnel under Ninth and Third Aves.

Below 14th and Houston Sts. the subways will be constructed partly by open cut, partly by tunnel methods.

Loss of Head to Aerate Filter Effluent

Extract from paper presented at recent meeting of Indiana Sanitary and Water Supply Association, by Malcolm Pirnie, with Hazen & Whipple, Consulting Engineers, New York.

THE APPARENT value of aeration applied to filter effluents has led to a modification in the usual design of mechanical filters for the plant which is to treat the new water supply at Providence, R. I. All of the variable head remaining between the effluent pipes and the water level in the pure water conduit is to be used in aerating the water. The usual type of controller throws this head away, by introducing friction losses in the effluent pipes to control the rate of flow. In the Providence plant, each filter effluent will be connected with a battery of spray nozzles of sufficient area to discharge the normal quantity of water under the head available when the filter is clean. Control is obtained by a variable orifice nozzle. A cone-shaped plug is inserted in a circular orifice and is arranged to close it completely when the filter is clean and to open the nozzle automatically to maintain the flow as the loss of head in the filter increases. If results similar to those obtained in experiments are realized, this equipment will cause an appreciable reduction in CO_2, increase in p^H and will necessitate the addition of a much smaller quantity of lime than would be the case without effluent aeration. Influent aeration will also be provided for the water and provision will be made to dose the water with aluminum sulphate either before or after it goes to the aerator.

Letters to the Editor

This department aims to be a forum for the discussion of the views of engineers and contractors. The range of interest should be as wide as possible. Contributors are, therefore, asked to make their letters short.

Engineers' Activity in the Mid-West

Sir—I note in *Engineering News-Record* of April 3, p. 586, you make mention of the International Professional Men's Club recently organized at St. Paul, Minnesota, particularly commenting on the fact that an engineer had been elected on the board of directors. I attended this conference at St. Paul, which was called by eight professional men's clubs organized in eight cities, and I wish to mention that while there were quite a number of attorneys and doctors, the engineers were also well reprsented, there being seven accredited engineer delegates out of a total of twenty-four.

Furthermore, there were two engineers elected on the international board of directors instead of one, as mentioned in your columns. The two engineers elected were Edward H. Bair of Milwaukee, Wis., and Arthur L. Mullergren, consulting engineer of Kansas City, Mo.

I think the point you were bringing out in your article was that the engineers are taking a more prominent part in social and civic activities. I might further mention that at this professional men's club conference the engineers were very prominent in formulating plans for the organization of the international body. It is the plan to extend the activities of this club to all of the larger cities, and clubs will be organized as rapidly as possible in each of the large cities of the country. This will bring the engineers into close contact with the other professions, which should have a tendency to give engineering its proper place among the professions.

ARTHUR L. MULLERGREN,
Consulting Engineer.

Kansas City, Mo.,
April 19, 1924.

More Light on the Cudahy Reservoir Failure

Sir—The failure of a reinforced-concrete reservoir in Cudahy, Wis., was described in *Engineering News-Record* of Feb. 14, 1924, p. 282. The writer has examined the plans for the reservoir and feels that there are some interesting lessons to be learned from this unusual solution of a problem which not infrequently arises. The lower part of the reservoir is of particular interest and was not constructed as shown in Prof. Pinney's sketch, although that fact was not evident after the failure.

Before the construction of the new reservoir which failed, an old square reservoir with concrete walls about 10 ft. high existed on the site. This was built about half in the ground and half above ground with an earth embankment thrown up around it. When it became necessary to increase the volume of water storage it was done by building up a square reservoir inside of the old walls to provide for a depth of water of about 10 ft. The total depth of the reservoir exceeded 30 ft. and it appears that there was about 30 ft. of water in the reservoir at the time of the failure. The walls of the new reservoir were constructed substantially as shown by Prof. Pinney. The lower part was cast inside of and against the old walls without any particular tie to them. The walls were reinforced as slabs between the vertical pilasters tied across the corners as shown, the center portion of each wall consisting of a vertical slab with horizontal beams between the two central pilasters.

With the tank full, the stresses in the diagonal tierods were about 14,000 to 15,000 lb. per square inch with the exception of the bottom ties which figure nearly 20,000 lb. per square inch, the designer apparently having relied on the horizontal resistance of the ground to reduce the stresses in the tierods.

The stresses in the reinforcing steel in the wall were in some cases high, anchorage of the tierods at the pilasters does not seem to have been sufficient, and the concrete of the walls was of poor quality. No turnbuckles were pro-

vided in the tierods when they were placed and there was some sag in them.

When the reservoir was filled for the first time, the walls bulged outward, opening the joint under the wall and up between the new and old walls, through which the water poured. Water also ran through the walls in many places. The reservoir was then emptied and an attempt was made to waterproof it by means of plaster and paint on the inside. This did not produce the desired results because when the reservoir was filled again the movement of the walls cracked the waterproofing and allowed the water to escape as before. The old wall was pushed out at the top so that a wide crack was visible between it and the new wall.

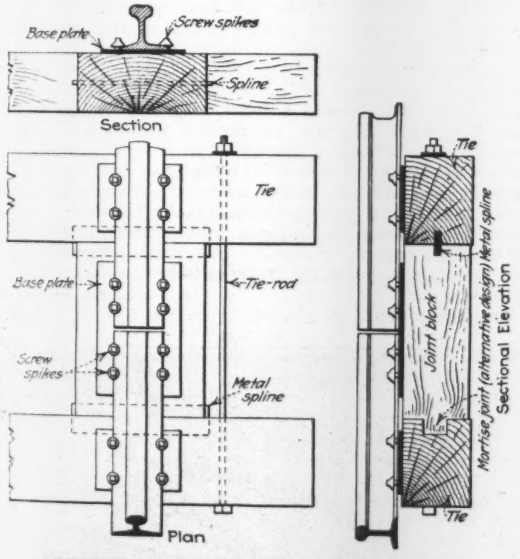
Finally, on the advice of a contractor, the diagonal tierods were cut and sections of plain round rods welded in so that turnbuckles could be inserted and the rods tightened up. The welds were butt welds, not well made, and of course they could not withstand the stress for which the original rods were figured. The failure of the ties at one corner would break the chain of ties around the reservoir and cause the almost simultaneous failure of the four walls as occurred.

The behavior of this reservoir emphasizes the absolute necessity in the design of monolithic concrete structures, of considering deformations as carefully as stresses. Even if the tierods in this case had been tight initially, there would still have been enough movement of the walls due to stretching of the rods to make waterproofing very difficult. If this reservoir had been properly designed and constructed, it would probably not have been as economical as some other type. That is often the case with ideas which at first glance seem very ingenious.

Milwaukee, Wis., April 18, 1924. CHARLES S. WHITNEY, Consulting Engineer.

A Non-Deflecting Rail Joint

Sir—Referring to the article, "A Non-Deflecting Rail Joint," on p. 485 of your issue of March 20, 1924, the writer is skeptical as to the successful operation of such a joint. But if such a joint should prove to be a success it



BRITISH NON-DEFLECTING RAIL JOINT

would solve the greatest difficulty in the way of adopting a U-rail instead of our present T-rail. The U-rail is about as efficient in design as the T-rail, as a beam, and a much better design for taking care of lateral thrusts.

The advantage in the writer's opinion, of the U-design over that of the T lies in the fact that the head or bearing surface of the rail would come under direct pressure of the rolls and consequently should be better adapted for the service required than is the head of our present T-rail; but the greatest advantage would be the tendency to change the piping from a vertical plane to a horizontal plane and thus decrease the bad effects of piping. The writer some fifteen years ago had authority from the management of the railroad he was then connected with to purchase for experimental purposes three miles of 90 lb. U-rail, but we could not design a joint that we considered satisfactory, and the experiment was not made.

Winnipeg, Man., March 27, 1924. J. G. SULLIVAN, Consulting Engineer.

[A sketch of the non-deflecting non-spliced joint is given herewith. As to the U-rail, its history was noted in *Engineering News* of July 1, 1915, p. 34. Of various joints for this rail the only one providing for a bolted splice appears to have been the proposed Wrenshall joint, in which the rail ends rested on a base plate having shoulders to fit the rail flanges and a rib making a tight fit in the hollow of the rail, the splice bolts passing through this rib and the webs of the rails. This joint was for rails on ties, but most of the U-rail tracks have had longitudinal stringers. Other U-rail joints had base plates with a central rib, but the rib was shallow and only designed to hold the rail ends in line, while in some cases a short bar fitting the hollow of the rail was spiked to the longitudinal timber for this purpose. In most cases the joint fastenings were screw spikes or through bolts in the rail flanges, but one design had a base plate with side shoulders only and bolted clips resting on these shoulders and the rail flanges. These clips might have been made in long pieces to act as horizontal splices, but it does not appear that any such splices were used.—EDITOR.]

Concerning Highway Traffic Counts

Sir—It was my privilege to hear Professor McKay's paper on "Highway Traffc Surveys" as delivered before the American Road Builders' Association in Chicago, and I have just now read his article in *Engineering News-Record* (March 27, p. 526) with much pleasure and profit. He has developed the traffic survey possibilities in a remarkably thorough and practical manner but I feel that he has not given due weight to other economic factors of prime importance.

Professor McKay in his paper sets forth fourteen results which may be obtained from traffic surveys. There are conditions actually existing with relation to the highways which seriously detract from the value of Professor McKay's conclusions unless they are taken into account by way of qualification. These qualifications I shall suggest in consecutive order.

1. Professor McKay says that by measuring the density and volume of traffic movement at selective points on the primary and secondary systems the relative importance of definite routes is established. The condition of a highway before it is paved has a great deal to do with the volume and density of traffic. I can best make this point clear by citing an example in my home state of West Virginia. In Pendleton County the most heavily traveled highway runs from the county seat in a central valley eastward across the mountain to a railroad point in Virginia. Due to the granting of state aid in West Virginia a north and south road in this central valley was graded and drained to such an extent with corresponding neglect of the main east and west road that traffic was diverted from its logical route east and west to the north and south route although neither highway has yet been paved. A traffic survey at this time would show the north and south road to be far more important than the east and west road although the exact contrary is true if the traffic could choose either road under comparable conditions of improvement. The point I wish to emphasize is that the underlying causes such as the location of the logical markets and trading points, the topography of the country, the trend of the population and the locations of resources to be developed, are all of more importance than the actual count of the traffic on any selected roads, as the volume and density of traffic may be arbitrarily stimulated or retarded by the condition of the highways at the time the traffic count is made.

2. Professor McKay states that highway design and construction can be adapted to the traffic load on different highways, while a traffic count on a highway already improved may aid in determining the adequacy of the pavement; this is hardly the case where a new pavement is to be laid on an earth road. Here Professor McKay's conclusion should be qualified, as the traffic load at the time

of a given investigation may be wholly different from that to which the highway would be subjected immediately after improvement. As an example, the highways of Spotsylvania County, Va., were graded and surfaced some years ago and as there was a considerable growth of timber suitable for railway ties in the sections traversed by the improved roads there immediately developed an excessively heavy new traffic from the hauling of railway ties. If, instead of determining the type of highway by a study of the traffic of the roads, the investigators would make a study of the resources which the building of these highways would develop, a fairly accurate idea of the kind of traffic could be formed. This again emphasizes the importance of making economic rather than statistical studies as the basis for highway improvement.

3. Professor McKay states that all highways on which traffic is measured become test roads and that by these measurements the life of the various types of highway can be measured. Professor McKay's points would be more forceful if he qualified his references to type of pavement by some reference to dimensions. If by type he means such broad classification as portland cement concrete, asphalt, brick, macadam or gravel, he at once loses himself in a wilderness of definitions. It would require a very elastic definition to include as one type a 6-in. 1:2:4 portland cement concrete pavement and a 9-in. 1 : 1½ : 3 reinforced-concrete pavement and to include as another type a 3-in. sheet asphalt top and binder on a 6-in. concrete base in comparison with a 2-in. asphaltic concrete on a 6-in. macadam base. If he attempts to subdivide these broad types he is up against the yet unsolved problem of comparable design. Who can say at just what point a traffic count will dictate not only a particular type of pavement but a particular set of dimensions, this again being complicated by subgrade and climatic conditions!

All of the remaining points made by Professor McKay are more or less open to the same process of analysis, leading to the same ultimate criticism; namely, that the traffic survey *per se* is an insufficient and possibly misleading criterion by which to classify the highways as to their relative importance and to apportion highway funds and select pavement designs. The traffic survey is of value if it is supported by other economic investigations and coordinated with them.

I realize that there is small merit in finding fault with a commendable achievement worthily performed unless something constructive is contributed along with the criticism. My suggestion is that an economic investigation should be made preceding any large construction outlay, such investigation to cover the economic possibilities in the creation of new traffic and the development of existing traffic. Among the questions to be studied would be these:

To determine by a study of the basic industries of a given territory the character and general direction of highway traffic which would best serve and develop those industries. For example, if the territory is one having very great resort and tourist attractions the routes which would not only make accessible these advantages but would connect them by the shortest and most feasible routes with the great centers of population should be seriously considered. If the territory is agricultural the roads which would enable the largest proportion of these agricultural products to reach their most profitable market or shipping point, not necessarily the nearest point, should receive consideration. Natural limitations, such as rugged mountains, difficult streams, swamps, marshes, deserts, should all be taken into account as restricting influences in the location and direction of highways. The class of traffic may be anticipated by a study of the kind of products which would logically pass over the highways after improvement, whether these products be railroad ties, iron ore, building brick, commercial supplies or manufactured products.

Even after a highway has been paved at large initial cost and traffic has developed to a remarkable degree the situation may change radically and thus render obsolete conclusions based upon a traffic study. An example of this is afforded by the Toronto-Hamilton highway which carried an ever increasing traffic until a year or more ago when another excellent highway by a wholly different route was completed between these two points with the result that the traffic of highway No. 1 was cut in half. Any conclusions as to the type of pavement of highway No. 1, if they were made without reference to highway No. 2, would be utterly misleading.

The whole force of my comment of Professor McKay's very able article is that there are definite and ascertainable economic bases which are much safer guides than mere traffic counts by which to shape our highway construction program.

J. E. PENNYBACKER,
General Manager, Asphalt Association.

New York,
April 9, 1924.

A Decrepit Highway Bridge

Sir—Some day, and it may not be far distant, the bridge shown by the two accompanying photographs may fall under load, and the general public will ponder as to the causes of its failure. Note the bulge in the upper chord member of the right-hand span and the joint marked *B* in the top chord of the left-hand span. Extreme frailness of the upper chord of the left-hand span at *A* has been caused by dry rot and falling away of the lower planks on the chord. The stone abutment at *C* is fast sloughing away, thereby allowing the span to settle. Probably theoretical calculations would show the bridge to have already failed under its present conditions. The bridge is on the main highway carrying automobile and truck traffic between Nashville and Ashland City.

Some time ago, on one of the highways of a neighboring state I crossed over a creek on the regularly traveled bridge and found posted conspicuously thereon a red sign which read about as follows: "This bridge is dangerous and should not be crossed." A similar sign may probably be necessary on the Marrowbone Creek bridge at an early date.

S. A. WEAKLEY.

Nashville, Tenn.

OLD WOODEN BOWSTRING-TRUSS BRIDGE IN TENNESSEE

News of the Week

CURRENT EVENTS IN THE CIVIL ENGINEERING AND CONTRACTING FIELDS

Canada Opposes Further Lake Diversion

Affect on Navigation Reason for Disapproval of 9-Ft. Lakes-to-Gulf Channel

Canada, through H. G. Chilton, British chargé d'affaires ad interim at Washington, has sent a note to Secretary of State Hughes expressing unqualified opposition to the plan for diversion of water from the Great Lakes to furnish a 9-ft. channel in the waterway from the Lakes to the Gulf of Mexico. Abandonment of the diversion of water by the Chicago Sanitary District is also requested. Loss of levels that would affect navigation in the St. Lawrence is the reason for the objection of the Canadian government. The letter, in part, follows:

"I have the honor to inform you that the government of Canada have recently noted that a special committee of the U. S. Senate has been appointed by the Vice-President to investigate the problem of a 9-ft. channel in the waterway from the Great Lakes to the Gulf of Mexico. . . . The Dominion Government further understand that certain legislation now before Congress proceeds . . . to confer upon the Sanitary District of Chicago the legal right to divert for sewage dilution and navigation purposes, 10,000 sec.ft. of water from Lake Michigan upon condition that the said district shall pay . . . its reasonable share of the cost of constructing compensating works at several points for the purpose of controlling and restoring to the Lakes in question the levels lost by reason of this diversion of water.

"In this connection, the dominion government observe that no provision is made for the restoration of the levels of the St. Lawrence River from its head to tidewater. In other words, the restoration to be provided in the legislation above-named is to be in the waters where the United States navigation predominates but no such restoration is provided for the waters so extensively used by Canadian shipping.

Navigation Affected

"Reports submitted to the Canadian government during recent months refer not only to the loss of levels that affect navigation, but also to the diversion of water for power purposes both in the international stretches where compensation may be determined and in the international stretches below Cornwall in the Province of Quebec. In that regard, Lord Byng of Vimy desires me to point out that the limit of 10,000 sec.-ft. as contemplated by the proposed legislation is about 1,500 sec.-ft. more than is being diverted at present, and his excellency considers it possible that the proposed legislation may mean that 10,000 sec.-ft. is allowed for diversion and power at Lockport, while additional waterpower will doubtless be required for lockages.

"In view of the above, I have the honor to inform you that the government of Canada are unalterably opposed to the proposed diversion of water from the Great Lakes watershed to that of the Mississippi to the great detriment of navigation from Sault St. Marie to tidewater. The diversion that has already taken place at Chicago has already lowered the water in the Great Lakes to an extent that is now common knowledge. This affects harbors upon which many million dollars have been expended in deepening operations. It also affects the locksills of the Sault St. Marie canals, the Welland Canal and the St. Lawrence canals, and, further, this diversion of water has a most injurious affect upon the ocean shipping channel between Montreal and the sea, where the government of the dominion have spent many more millions of dollars in dredging operations. . . . The government of Canada, therefore, sincerely hope that the government of the United States will not only not permit any further diversion from Lake Michigan, but will intimate to, and if necessary insist upon the Sanitary District of Chicago adopting some more scientific method of sewage disposal than is foreshadowed at present. . . ."

Flint Bond Limit Held Invalid By City's Attorneys

Although the April 7 vote in Flint, Mich., authorized an increase in bonded indebtedness from 7 to 9 per cent of the assessed valuation by a majority of 42 the city's bond attorneys, Wood & Oakley, Chicago, have ruled that a three-fifths majority is necessary. The city attorney had ruled in the same way but the attorney-general of the state had ruled that only a majority was essential.

The ruling affects the sewage-disposal program since the city is within a million of its limit under the 7 per cent limit. A bond issue election for sewage disposal funds will likely be submitted within the month. The amendment to increase the debt limit may be presented at the special election or at a later date.

According to the 3-year program laid out for the sewage disposal project 4,000 ft. of 7-ft. intercepting sewer and 18,000 ft. of 48-in. pressure main should be built in 1924. The design of the disposal plant proper will not be started until late this season. In the meantime results are being obtained at a testing station under the general supervision of George M. Osborne, city engineer, by James R. Pollock, special sanitary engineer.

Union Carbide Co. Makes New Muscle Shoals Bid

Guarantees $120,000,000 Return to Government Over 50 Years—Testimony Continues

Washington Correspondence

Statement that disposition of the government's properties at Muscle Shoals need not depend primarily upon possible recovery of the nitrate plants for the production of munitions in the event of future war, and the new offer of the Union Carbide Co. of New York, were outstanding events in the week's inquiry into Muscle Shoals. The Senate committee on agriculture was told by Major Gen. C. C. Williams, chief of the army ordnance department, that commercial production of ammonium nitrate at other plants in the country has reached the point where the War Department would have no fears as to its source of supply should war come. Gen. Williams also told the committee that the production of these private plants could be stimulated sufficiently, in his opinion, and that so far as fertilizer is concerned, ammonium sulphate is now being exported by private producers. It is desirable that the price be reduced through lowered cost of production, he pointed out.

Carbide Company Offer

The Union Carbide Co. submitted a new offer to the committee, guaranteeing production of a new fertilizer and a return of $120,000,000 to the government for a 50-year lease on the plants. The same company had submitted a previous bid at a lower figure. Senator Norris, by request, introduced a bill for another government corporation to operate the properties, drafted by former Representative J. L. Lloyd, of Missouri.

W. G. Waldo, consulting engineer and secretary of the Tennessee River Improvement Association, advocated the Ford offer before the committee. He opposed the suggestion that power from Muscle Shoals be distributed over a wide area, asserting that the dependable power development is 241,300 hp. and that to produce 40,000 tons of nitrogen for fertilizer would require 257,000 hp. were an average production maintained throughout the year. Major E. B. Stahlman, publisher of the Nashville *Banner*, urged acceptance of the Ford bid without amendment but admitted he was not familiar with other offers.

Secretary of War Weeks told the committee all bids are inadequate and urged appointment of a committee or commission with power to negotiate for disposition of the properties. Gov. Pinchot of Pennsylvania, urged distribution of the power through a superpower system.

Propose 6,153-ft. Span for Power Line

Plans of Cushman Project Contemplate Bridging Narrows of Puget Sound With Record Span

Plans for the Cushman Power Project, which is being built by the city of Tacoma, Wash., contemplate carrying two 3-phase, 110,000-volt transmission lines over "The Narrows" in Puget Sound, using a span of 6,153 ft. This would constitute a new record span, being more than 1,100 ft. longer than the longest of four similar spans now in successful operation, namely: two crossings of Carquinez Straits, on San Francisco Bay, 4,427 ft. and 4,753 ft. long, respectively; one over the St. Lawrence River near Quebec, 4,801 ft. long; and one of 5,010 ft. over the Little Tennessee River in North Carolina.

"The Narrows" is the only outlet to the ocean of the lower end of Puget Sound and is traversed by swift tidal currents. The bottom is rocky and uneven and the shores are fringed with high, steep bluffs. Under these conditions the use of submarine cables was found impracticable. To go around the lower end of the Sound would necessitate a greatly increased length of transmission line and final decision was that the best solution would be to carry the conductors over the Narrows in a long span.

Type Selected

The messenger type of span was selected and plans call for conductors of 300,000 c.m. copper or equivalent aluminum, supported by 1¼-in. galvanized plow steel concentric-wound messenger cables passing over large sheaves in the towers and continuing downward into heavy anchorages deeply embedded in the earth. Over the towers and at anchorages the messenger lines would be reinforced.

Loaded with ice and with no wind blowing, the sag of these cables would be 368 ft., at which deflection they would clear the water by 200 ft. The cables are designed to be safe, when conductors, insulators and cables are covered with a ½-in. ice coating and a 72-mi. gale is blowing. Although the cables specified are to have a strength of 195,000 lb. per sq.in. over the net steel cross-section, their safe working strength is figured at 90,500 lb. per sq.in.

There are to be six cables, comprising two separate circuits, each having its own pair of towers and anchorages, with a spacing between sufficient to allow one circuit to be cut out of service and repaired without danger from cables of the other circuit. This arrangement is expected to insure uninterrupted service, as each circuit will be capable of carrying the full load of the project indefinitely. The towers, of structural steel, are to be 150 ft. back from the brink on each side. Those on the east shore would each be 272 ft. high and those on the west 325 ft.

The plans are being pushed to completion in the endeavor to finish the proposed span in time to put it under test for at least a year before it goes into actual service.

Would Bridge Lake Champlain

A resolution urging the Congress of the United States to investigate the feasibility and practicability, in co-operation with the authorities of New York State and the State of Vermont, the construction of a vehicular bridge across Lake Champlain, was passed by the New York State Legislature and copies of such resolution transmitted to the Congress of the United States and to the governor and legislature of the State of Vermont.

Eads Unveiling Set for May 13

A bust of Capt. James Buchanan Eads, noted engineer, will be unveiled in the Hall of Fame, New York University, on May 13, 1924. Edward E. Wall, chairman of the committee of the American Society of Civil Engineers in charge of the arrangement, will present the bust, which has been secured through the generosity of the members, and George F. Swain, past-president of the society, will make an address. The unveiling will be done by one of the grandsons of Captain Eads, after which the exercises will be continued in the large auditorium adjoining the Hall of Fame. This action will, for the first time, place an eminent engineer among the immortals of the Hall of Fame.

Third Zoning Commission Created at Philadelphia

A renewed effort for zoning has been made in Philadelphia with the appointment by Mayor Kendrick of a zoning commission, made up of representatives of a number of civic organizations. The present zoning commission is the third one created in Philadelphia. The first zoning commission was appointed by Mayor Smith in 1916, after the State Legislature of that year had passed an enabling act. The first commission prepared extensive maps and made detailed studies of the entire city, and in 1919 submitted a zoning ordinance.

The succeeding administration under Mayor Moore appointed a similar commission, which reviewed the work of the previous commission, and in October, 1921, submitted the second proposed zoning ordinance. Opposition developed to the heights specified in this ordinance for the central portion of the city, and the ordinance was not approved by council.

The zoning commission appointed by the present administration has representatives of the Philadelphia Builders' Association, the Engineers' Club of Philadelphia, the Chamber of Commerce, the American Institute of Architects, the Builders' Exchange, the Real Estate Board, and the Philadelphia Housing Association. George H. Biles, director of the Department of Public Works, is chairman of the commission. Conrad N. Lauer, president of the Engineers Club and B. J. Newman represents the Engineers Club, Mr. Newman being also representative of the Philadelphia Housing Association.

Providence Asks Bids on 50 M.G.D. Filters and on Conduits

Bids for the new water purification plant of Providence, R. I., and portions of the Scituate aqueduct adjacent thereto between the main dam of the Scituate reservoir and the west portal of the Scituate tunnel will be received by the Water supply Board on May 21. The purification works include a 50-m.g.d. rapid sand filter plant with provision for subsequent extension to twice that capacity, influent and effluent aerators, large uncovered coagulation basins of 160-m.g capacity to be formed by earth dams, a reinforced-concrete wash-water tank, settling basins for wash water, superstructures and other appurtenances.

The portions of the aqueduct covered in this contract include two 60-in. steel pipes each about 1,700 ft. long with blowoffs and other connections, about ½ mile of 94-in. diameter steel pipe surrounded with concrete and lined with 2 in. of mortar, and about 600 ft. of 90-in. diameter reinforced-concrete aqueduct. The work is located in the town of Scituate about ten miles west of the city of Providence and about two miles north of the village of Hope, which is the nearest railroad station.

The approximate quantities of the principal items of the work are: Excavation and embankment, 500,000 cu.yd.; concrete masonry, 29,000 cu.yd; brick masonry, 1,300 cu.yd.; cast iron, 700 tons; steel and miscellaneous metal work, 3,610,000 lb.; filter sand and gravel, 3,000 cu.yd. The time allowed for construction is 30 months with a provision that parts of the plant must be ready for use in 22 months. B. Thomas Potter is chairman of the Water Supply Board and Samuel N. Grammont is secretary. Frank E. Winsor is chief engineer, William W. Peabody deputy and Francis B. Marsh, designing engineer. J. Waldo Smith and Allen Hazen, New York City, are consulting engineers for the entire project. The plans for the purification works were prepared by Hazen & Whipple.

New Brunswick Plans for Power Development at Grand Falls

Premier P. J. Veniot of the Province of New Brunswick, Canada, has announced that the provincial government will undertake the development of the power site at Grand Falls on the St. John River. Harry G. Acres, hydraulic engineer of the Ontario Hydro-Electric Power Commission, recently made a report to the New Brunswick Provincial Government on the power possibilities of this site in which he stated that the ultimate capacity would be from 120,000 to 140,000 hp., but that as the St. John River is international in character and as the greater part of the area available for storage reservoirs lies within the State of Maine, the storage available in Canada would provide only from 60,000 to 80,000 hp.

According to Premier Veniot's statement, the provincial government will not undertake actual construction until the co-operation of the United States Government has been secured.

Engineers Report Brooklyn Elevated Structures Safe

Old Design and High Stresses in Details but Conditions Declared Not Unsafe

A report on the condition of the elevated railways in Brooklyn, New York, has been made by a board of three engineers representing the city, the Transit Commission, and the operating company (Brooklyn-Manhattan Transit Co.). The members of the board were Prof. George F. Swain, Robert Ridgway, and Eugene Klapp, the latter acting for the company. Its appointment followed a serious derailment last June, in which several persons were killed. The investigation covered the structure, the track, the rolling stock, and the signaling and other safety equipment.

On the basis of a full examination the board finds the elevated structure to be safe, though old in design and containing many inferior details subject to high stress. In a few places it recommends strengthening, and at one point, where the deck of the railway is at a considerable height above the street, it suggests that additional bracing be inserted between the columns. Although the structure is twenty to thirty years old, corrosion is serious only at certain unprotected column bases, where the metal is in contact with the ground or is exposed to the influence of snow, rain and rubbish accumulation. Occasional instances of marked corrosion of the longitudinal girders are also noted, but in general the overhead structure shows no serious loss of section. Painting has not been kept up satisfactorily, and more careful maintenance painting is recommended. The column bases exposed to corrosion are to be encased in concrete.

Track Construction

In its report on the track construction, the board finds conditions generally satisfactory, but criticises the guard timber arrangement. At present both inside and outside guard timbers are used, each 6 x 6 in.; the board recommends a steel guard rail inside, the outer guard timber to be retained only as a tie-spacer. The condition of the ties is not found altogether satisfactory, chiefly because of the company's practice to renew individual ties. Simultaneous renewal of all the ties in a given length of track is recommended.

Many defects and weaknesses in rolling stock are brought out in the board's report. They are attributed to the fact that much of the equipment is old and obsolete and inspection and maintenance of equipment are inadequate.

A committee of the city's Board of Estimate, to which this engineering board reported, supplements these recommendations with additional findings. It declares that the steel elevated structure is obsolete and can be considered safe only for the light rolling stock now in use on the system, much of which is due to be retired shortly. Modern steel cars cannot safely be operated over most of the system, in the opinion of the committee. It lays stress on the inefficient maintenance of rolling stock, evidenced by many serious defects found in the cars even directly after they had gone through the shops for overhauling, and by the excessive number of train delays due to rolling-stock defects. This committee consisted of John H. Delaney, Arthur S. Tuttle, and Geo. P. Nicholson.

Denver Plans 64-M.G.D. Filters

Plans for a new 64-m.g.d. filtration plant for Denver, Col., have been completed. They call for rapid filters, an aerator, coagulation basin and filtered-water storage reservoir. Water is to be drawn from Marston Lake through a new intake 1,200 ft. from the shore with provision for taking water at different levels. A rough screening plant is included. The estimated cost of the intake is $150,000 and of the purification works $1,000,000. The plans have been prepared under the direction of Burton Lowther, chief engineer and general superintendent of the Board of Water Commissioners. James H. Fuertes is consulting engineer and F. H. Weed, resident engineer.

First International Management Congress to be at Prague

At Prague, Czechoslovakia, will be held July 21-24, 1924, the first international mangement congress. This congress was conceived and planned by the government of Czechoslovakia and the Masaryk Academy of Prague, which by invitation through American Engineering Council to the four founder societies secured American participtation. Arrangements for attendance may be made through the joint committee on American participation, which may be addressed at the Engineering Societies Building, 29 West 39th St., New York City.

Hudson River Board Files Plans for Sacandaga Reservoir

Plans for the construction of the Sacandaga storage reservoir on the upper Hudson River have been filed with the New York Water Control Commission by the Hudson River Regulating Board. This is the preliminary step toward the construction of the reservoir required by law. Before construction can be started the plans must be presented at a public hearing and approved by the Water Control Commission.

The proposed dam will be in the neighborhood of Conklingville, N. Y.; and earth-fill structure approximately 100 ft. high. The reservoir will be 25 miles long and four miles wide at the widest point and will have a storage capacity of 37,800,000,000 cu.ft. The estimated costs are:

Property damages	$2,200,000
Dam	2,300,000
Clearing land	710,000
Relocation of roads and railroads	1,115,000
New Bridges	360,000
Miscellaneous	725,000
Overhead	990,000
Total	$8,400,000

H. M. Byllesby Dies Suddenly

Active Head of Public Utilities Firm and Pioneer in Power Development Succumbs in Chicago

H. M. Byllesby, active head of the utilities organization which bears his name and pioneer in the field of hydro-electric power development, died suddenly of heart failure in Chicago, May 1, at the age of 65 years. Mr. Byllesby was born in Pittsburgh, Pa., in February, 1859. He received his technical education at Lehigh University. After leaving college he spent two years in the college engine works of Robert Wetherell & Co., in Chester, Pa., and in 1881 entered upon his business career in the electrical field, obtaining employment with the Edison Electric Light Co. in New York.

The first large job on which he assisted Mr. Edison was the establishment of the old Pearl St. power plant for the electric lighting of New York City, which was the first steam-operated central station in the United States. At the age of 26 he was made vice-president and general manager of the Westinghouse Electric Co.

Pioneer in Power Development

Always interested in pioneer engineering having to do with power development, Mr. Byllesby was identified with a number of organizations during his early professional career. As managing director of the Westinghouse Electric Co., Ltd., of London, as president of the Northwest General Electric Co. with headquarters in St. Paul, director of the business of the General Electric Co. in northern Michigan, northern Wisconsin, Minnesota, North and South Dakota, Montana, Wyoming, Idaho, Washington and Oregon, he gained the background and experience for launching his own public utilities organization in January, 1902. Prior to that time he had spent four years in Montana making a personal examination of the power possibilities. At that time power development for congested eastern districts was considered feasible but entirely radical for sparsely populated sections of the West.

He gained particular note by revivifying public utilities which had sickened through too much political handling.

Mr. Byllesby was a member of the American Society of Mechanical Engineers, the American Society of Civil Engineers, the American Institute of Electrical Engineers, and a number of social and professional clubs in Chicago, New York, and other cities. During the war he was appointed a lieutenant-colonel in the Signal Corps and acted as general purchasing agent for Base Section No. 3, American Expeditionary Force, which included the British territory occupied by American troops. For this service he was awarded the Distinguished Service Medal and the British D.S.O.

Washington Paragraphs

Delay in Reporting on the Bill authorizing $85,000,000 yearly for three years for federal-aid roads has been caused by the inability of the government printers to prepare copies of the bill. Road building with the United States a participant will not be held up, however, unless the bill does not pass by Jan. 1, 1925. Meanwhile, passage of the agricultural appropriation bill by both houses is hoped for at an early date so that the $75,000,000 which it carries for federal-aid roads for present uses may become available.

After Having Considered all Details of the proposed boulevard between Washington and Mount Vernon, the House Committee on Roads is ready to report the bill favorably. The roadway, which is to have a 200-ft. right-of-way, will start from the Virginia end of the new Arlington bridge. A portion of the existing road will be utilized and the paved surface is to have a width of at least 32 ft. The road is to be constructed entirely with federal money and it is expected will cost slightly in excess of $1,000,000.

Extensive Preparations have been made for the reception of the delegation of highway engineers from Latin America who will assemble in Washington June 1. A number of social features have been provided for them in the capital. On June 3, accompanied by representatives of the Bureau of Public Roads and the American Association of State Highway Officials, the visitors will attend the Road Show at Greensboro, N. C.

Considerable Additional war equipment which can be utilized in highway construction will be made available to the states in the near future, it is believed. Recent hearings have indicated that the War Department is carrying a great deal of excess equipment. It is said that much of this equipment has been allowed to deteriorate uselessly and a congressional delegation has conferred with the Secretary of War on the subject. He has promised to adopt vigorous measures to secure immediate transfer of such material to the Bureau of Public Roads. In addition, a bill will be reported intended to require more accurate reporting of surpluses.

Observers for the U. S. Weather Bureau report that there were no particularly unusual features in connection with the destructive tornado which recently crossed the southeastern states. The storm moved in a straight line in a northeasterly direction. The destructive center of the storm rose and fell somewhat more frequently than is usual, the storm moving at such a velocity. The havoc wrought was increased by the fact that a large percentage of the buildings in the area were not of substantial construction. The more usual path of such storms is farther west than the area visited in this recent instance.

Order Stopping Kansas City Water Works Improvement Denied

The application brought in the Federal Court by non-resident taxpayers for an order stopping the large program of water-works improvements being carried out by Kansas City with Fuller & Maitland as engineers has been denied by Judge Van Valkenburg and the temporary restraining order dissolved. The court ruled on May 6 that the additional supply works are improvements and betterments which the city has a right to make under its charter and not new works. Details of the case in its earlier stages were published in *Engineering News-Record* April 24, p. 742. Since then the city administration that recently took office has appointed a new fire and water board, two of the three members of which were on the old non-partisan water board mentioned in our news article cited above.

Ontario Hydro to Enlarge Nipigon River Development

The Provincial Hydro-Electric Power Commission of Ontario will immediately call for tenders for units 5 and 6 of the Nipigon power development of 12,000 hp. each. These units, with units 3 and 4 now under construction, will bring the total capacity of the plant up to 72,000 hp. The Commission is faced with a demand for 53,000 hp. at the present time. The Commission is considering raising the level of Lake Nipigon in order to increase the output of its plant to supply more power to Ft. William and Port Arthur at the earliest possible date.

British Sewage Engineer Resigns

The many American engineers who have received courtesies from John D. Watson, engineer to the Birmingham Tame & Rea Drainage District, Birmingham, England, or who have met him during his professional trips to this country, will be interested to know that Mr. Watson has resigned, effective March 31, in order to enlarge his consulting work. The board mentioned has voted Mr. Watson a pension of £900 per annum and has also appointed him consulting engineer at £300 a year additional.

Mr. Watson has been engaged by the municipality of Bombay as consulting engineer for a large sewerage project. He has also recently been made a member of the Council of the Institution of Civil Engineers, which he states requires that he spend much of his time in London. A son of Mr. Watson is a member of the firm of Dodd, Dodd & Watson, engineers for water supply and sewerage.

H. C. Whitehead, chief assistant to Mr. Watson, has been appointed as chief engineer of the Birmingham Tame & Rea District Drainage Board. Mr. Whitehead became associated with Mr. Watson in the Drainage Board some twenty years ago. After having been away for some thirteen years he returned about four years ago to become chief . sistant.

Random Lines

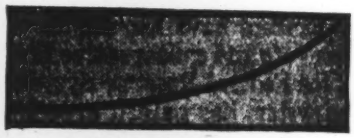
In Wildest Manhattan

"A dealer in brick declares that in the thirty-four years he has been in trade there never before was such a movement of brick directly to the consumer. A policeman, sometimes two, rides on every lorry of brick that moves from the barge to the place where it is used, for in this frenzy of new construction the labor unions have seen new opportunities. They would, if they could, prevent the laying of a single brick or the nailing of a lath that had not been carted by union labor. The actual workers on the buildings, however, are not over-particular for the moment, are willing enough, indeed, to disregard the strict letter of union obligations when every hour of activity brings them in from 6s. to 8s. Therefore while some of the lorries, though very few, are held up, most of them arrive at their destination."

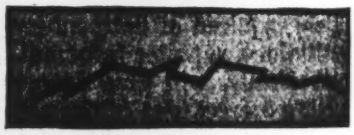
One has to go away from home to get the news. This report from the London *Times* will explain to New Yorkers where all the policemen who ought to be guiding traffic have gone. But is the *Times* sure that these lorry-riding cops are not protecting the drivers from hostile Indians!

* * *

Graphical Representation For the Masses



This graph shows the regular increase in the expansive force of Stanocola gasoline.



This shows the jerky, quickly decreasing expansive force of a low-grade gasoline.

From an ad of the Standard Oil Co. of Louisiana

No wonder the automobile driven with that other fellow's gasoline bucks and charges.

* * *

Medico-Engineering

The osteopath is by education a physician. He practices a new and complete system of treatment. He diagnoses a case and treats it. He must know diseases in all their phases and manifestations. He must be a skilled anatomist, for he is an anatomical engineer. —From *The Osteopathic Magazine.*

A. E. Kiesling, who put up a million prescriptions in his drug store for Houston folk and then sold his business, is pursuing the interesting vocation of a pharmaceutical engineer these days.—From the Houston *Post.*

Engineering Societies

Calendar

Annual Meetings

NATIONAL FIRE PROTECTION ASSOCIATION, Boston, Mass.; Annual Meeting, Atlantic City, N. J., May 13-15, 1924.

AMERICAN WATER WORKS ASSOCIATION, New York City; Annual Convention, New York City, May 19-24, 1924.

AMERICAN ASSOCIATION OF ENGINEERS, Chicago, Ill.; Annual Meeting, San Francisco, Calif., June 11-13, 1924.

AMERICAN SOCIETY OF CIVIL ENGINEERS, New York City; Annual Convention, June 18-20, Pasadena, Calif.

AMERICAN SOCIETY FOR TESTING MATERIALS, Philadelphia, Pa.; Annual Meeting, Atlantic City, N. J., June 23-28, 1924.

SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION, University of Pittsburgh; Annual Meeting, Boulder, Colo., June 25-28.

AMERICAN SOCIETY FOR MUNICIPAL IMPROVEMENTS, St. Petersburg, Fla.; Annual Convention, Boston, Mass., Sept. 29-Oct. 3, 1924.

The Boston Society of Civil Engineers, Designers Section, has invited the Affiliated Technical Societies of Boston to its meeting, May 14, at which Major Stuart C. Godfrey, engineer-officer, Ist Corps Area, will discuss the Muscle Shoals project.

Personal Notes

ERIC HAQUINIUS has resigned as photo-topographic engineer of the U. S. Geological Survey to become chief engineer of the Aerial Surveys, Inc., Washington, D. C.

L. B. ELLIOTT has been appointed engineer of maintenance-of-way on the Cincinnati-Sandusky division of the Cleveland, Cincinnati, Chicago & St. Louis Ry., with office at Springfield, Ohio. He succeeds W. S. BURNETT, promoted to engineer of construction.

FRANK A. RANDALL, consulting structural engineer, Chicago, has moved his offices to 160 North LaSalle St.

B. S. BADGER, of the California State Highway Commission has been transferred from Bishop, Calif., to the headquarters of the commission in Sacramento, where he assumes the duties of assistant to Maintenance Engineer A. J. Wagner.

METCALF & EDDY announce that they have admitted to the firm, as a junior partner, JOHN PRESCOTT WENTWORTH, who has been in their employ since 1911.

JOSEPH S. STROHMEYER, who has been in the city employ of Baltimore, Md., for fifteen years, has been made distribution engineer of the water department. The water board also has appointed OSCAR M. BLOCK as assistant structural engineer in the filtration division.

WIGTON-ABBOTT CORP., engineers and contractors, 552 West 23rd St., New York City, has been organized, with C. B. Wigton, president, and E. P. Abbott, vice-president. The corporation has taken over the general contract organization of the Levering & Garrigues Co. and will render service in general building construction.

C. A. HANDEYSIDE CONSTRUCTION Co., Detroit, Mich., announces removal May 1 to the General Motors Building, Detroit.

L. G. SMITH, formerly bridge engineer for the Alabama State Highway Department, has been made chief locating engineer of the department. His successor in the bridge engineering work is H. H. Houk, formerly highway bridge engineer for the U. S. Bureau of Public Roads, Eighth District.

ERWIN DAMES, formerly superintendent of public works at Winnetka, Ill., is now in the office of the city engineer at Santa Barbara, Calif. Mr. Dames is a graduate of the University of Wisconsin, and previous to his work in Winnetka was in the office of Webster Burham, consulting municipal engineer, Kansas City, Mo.

BURTON M. HILL, chief highway engineer for New Brunswick, N. S., has been appointed a director and chief engineer of the St. John and Quebec Ry., with office at Fredericton, N. B. He retains his position as chief highway engineer.

W. V. BUCK has been appointed Kansas representative of the Portland Cement Association with headquarters at Topeka, Kansas. Mr. Buck was assistant state highway engineer for several years after leaving the army and has been engaged in the automobile business at Newton for the past year.

R. W. ARMSTRONG has been appointed county engineer of Johnson County with headquarters at Olathe. Mr. Armstrong has been division engineer of the Northwest district during the past year. Previous to that time he was resident engineer on the federal-aid projects in Doniphan County.

J. C. PEARSON, for a number of years connected with the U. S. Bureau of Standards, recently engineer-physicist in charge of the concrete and allied investigations, has resigned to become associated with the research activities of the Lehigh Portland Cement Co. as assistant to the chemical engineer, with headquarters at Allentown, Pa.

COL. WILLIAM G. ATWOOD, formerly director of the recently completed marine piling investigations of the National Research Council, has severed his connection with the Council. Colonel Atwood is at present abroad making a study of European harbor and inland waterways developments, and will take up consulting work in that field on his return to the United States June 1. To this practice he will bring an extensive engineering experience, as he has intimate knowledge of port developments through his service with the National Research Council, and, as a member of the staff of Herbert Hoover in the American Relief Administration, has made studies of European transportation systems, both water and rail.

Obituary

BRIG.-GEN. ISAAC W. LITTELL, Q. M. Corps, U. S. A., retired, died in Washington May 1 after a short illness. He was born in Elizabeth, N. J., in 1857 and was graduated from West Point in 1883. During the World War he was chief of the cantonment division, Quartermaster's Corps, in charge of construction of cantonments and national guard camps. He retired in 1918 and since then has been secretary and treasurer of the Soldiers' Home in Washington, D. C.

ALBERT LADD COLBY, consulting engineer, Bethlehem, Pa., died recently in that city, aged 64 years. Mr. Colby was born in New York City in 1860 and was graduated from the School of Mines, Columbia University. For a short period he was assistant professor of analytical and applied chemistry in Lehigh University. From 1886, for many years he was in the service of the Bethlehem Iron Co. and Bethlehem Steel Co., first as head chemist, later as metallurgical engineer. Since 1886 he had also served as consulting engineer for several steel companies and expert in iron and steel patent suits. He was U. S. representative at the international congress for testing materials in Paris in 1900 and a member of Committee No. 1, American Section, of the International Association for Testing Materials. He took an active part in drafting the American standard specifications for steel and was representative of the American Society for Testing Materials on Engineering Council.

EDGAR G. BLANKMAN, Watertown, N. Y., engineer and a pioneer map maker of the northern section of New York state, died recently while on a visit to Constantia, N. Y.

DR. ERNEST FOX NICHOLS, of the pure science staff of the Nela Research Laboratories of the National Lamp Works, Cleveland, Ohio, and former president of both Dartmouth and Massachusetts Institute of Technology, died April 29 while closing his address at the time of the dedication of the new home of the National Academy of Sciences in Washington, D. C. Dr. Nichols was born in Leavenworth, Kansas, in 1869. His education was obtained at Kansas Agricultural College, Cornell University, University of Berlin and Cambridge University. He was professor of physics at Colgate University, Dartmouth College, Columbia University and at Yale. From 1908 to 1915 he was president of Dartmouth, resigning to join the Yale faculty. He was elected president of M.I.T. in 1921. During the war he was connected with the Bureau of Ordnance of the Navy. In 1905 he was awarded the Rumford Medal.

ALEXANDER EDGLEY, superintendent of bridge construction, Canadian National Rys., at Limoilou, Quebec, died April 8 after forty years' service with the railway.

From the Manufacturer's Point of View

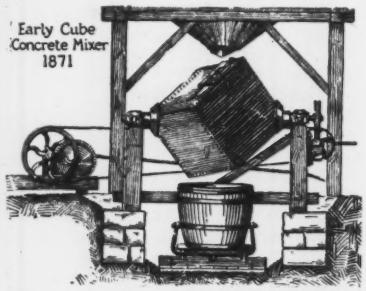
A Point of Contact
Between Maker and User of
Construction Equipment and Materials

Construction Equipment—Past and Present

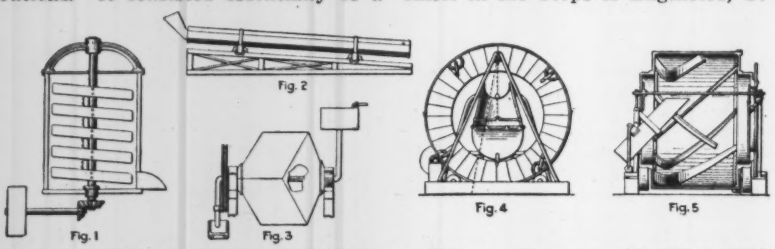
A Series of Historical Sketches of the Origin and Development of Machines for Contractors and Engineers

III—The Concrete Mixer

FROM a wooden barrel with paddle arms revolving horizontally within it and mounted on a central vertical shaft, the concrete mixer has evolved during 74 years through stages of long rotating tubes and wooden boxes mounted on trunnions into the present-day reliable, efficient and durable power-driven metal drum types for both building and paving purposes. The early history of the concrete mixer is built around the efforts of one man, Ernest L. Ransome. Born in England in 1846, he came to this country and turned his inventive genius to the task of developing methods and machines for extending the use of concrete beyond the field of ornamental flower pots and baptismal fonts. In this effort he was following in the footsteps of his father, Frederick Ransome, whose first mixer, produced in 1850, is shown in one of the illustrations. It consisted essentially of a set of paddle arms revolving horizontally within a barrel. The second stage of this machine was reached in 1859 when a mixer of the pug-mill type with shallow pan and two paddle-wheels mounted on a horizontal shaft revolving about a vertical axis was produced. The usefulness of this machine was limited to the fine and very wet mixtures used in the manufacture of "Ransome stone."



Revolving Wooden Cube Mixer, Fort Scammell, Portland, Me., 1871



Stages in Ransome Mixer Development: Fig. 1—*Horizontal Paddles,* 1850. *Fig.* 2—*Revolving Cylinder,* 1875. *Fig.* 3—*Wood Cube,* 1876. *Fig.* 4—*Wood Drum with Removable Shelves,* 1885. *Fig.* 5—*Metal Drum with Blades,* 1902.

Revolving Cube—After experimenting with a mixer in the form of an inclined hexagonal wood drum 30 ft. long and 30 in. in diameter, in which mixing was accomplished simply by rolling contact without deflectors, an entirely new principle was followed in the use of a wooden cube rotated on hollow trunnions through which water was fed to the batch. In a later model materials were charged into the drum through enlarged hollow trunnions. This machine dates from the early seventies, and while the Ransome records fix the introduction of this form of mixer in the year 1876, a similar machine is shown in a drawing dated 1871, appearing in Brig. Gen. Q. A. Gilmore's "Practical Treatise on Limes, Hydraulic Cements and Mortars," published in 1872. The device noted by General Gilmore, who was an officer in the Corps of Engineers, U. S. Army, was used at Fort Scammell, Portland, Me. This mixer is spoken of as a mill and was in the form of a 4-ft. cube provided with a trap door 2 ft. square for the discharge of the batch. Of this mixer General Gilmore says: "Eight revolutions of this box, made in less than 1 min., are found to be quite sufficient to produce the most thorough incorporation of the mortar with the broken stone and gravel. Every piece of stone and every pebble and gravel become completely coated over with the mortar."

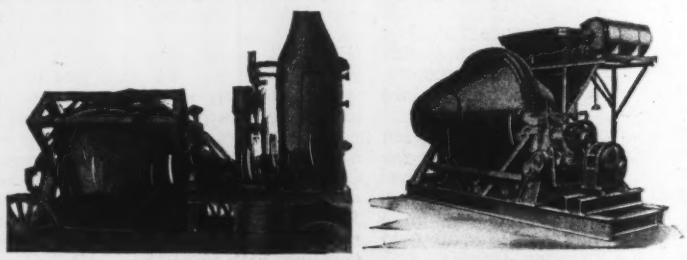
General Gilmore foresaw, in those early days, the advantages of power loading, for he advocated the charging of the box "by a crane or derrick worked by the same engine that turns the box" instead of the wheelbarrows actually used. This mixer, it is recorded, had an output of from 95 to 100 cu.yd. of concrete in one day of 10 hr. and did "the work very much better than can be done by hand at a saving of from 15 to 20 per cent in the cost of labor."

The revolving wooden box was the real forerunner of the present-day batch mixer. Excessive wear and heavy impact of material within this container, however, led to the use of a cylindrical form for the drum and the substitution of metal for wood. In those days, however, the use of concrete as a structural material was extremely limited, but Ransome gave a great impetus to the development of the mixer by constructing, in 1887, a factory, said to be the first reinforced-concrete structure in the United States. Two years later there is record of the use of concrete for residential structures—two hotels at St. Augustine, Fla., in which the concrete materials were "mixed in two tumbling boxes of the usual type."

Modern Ransome Mixer on Hudson Vehicle Tunnel

With a tremendous field for the use of concrete opened up in the eighties, the development of the concrete mixer made rapid strides. In 1885 Ransome developed a machine of the cylindrical wooden-drum type with movable blades, the prototype of the modern mixer. Later metal instead of wood construction was used and the drum was provided with fixed blades as shown in one of the illustrations. This machine also was fitted with a tilting chute; a gear and pinion drive replaced the former chain belt and sprocket.

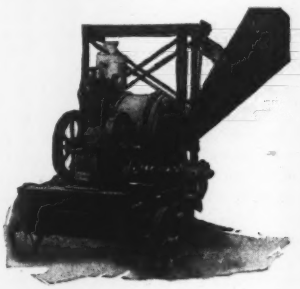
Tilting Mixer—Enough pioneer work



Earliest and Latest Smith Tilting Mixers

had been done by this time to indicate clearly an immense commercial field for the concrete mixer, and inventors and manufacturers began to direct their efforts toward the improvement of the machine. Among the first of these was T. L. Smith, a graduate of Iowa State College (class of 1877) and later an instructor in mathematics. In 1899 he developed and patented a mixer involving several new features. The drum of the Smith machine was in the form of a dual cone and was mounted on a frame-work which was tilted to discharge the batch. This first tilting mixer had a capacity of about 10 cu.ft., was operated by a chain drive from a steam engine with a cast-iron crank shaft. Another feature of this machine, which was continued in later models, was the single combined gear ring and roller track.

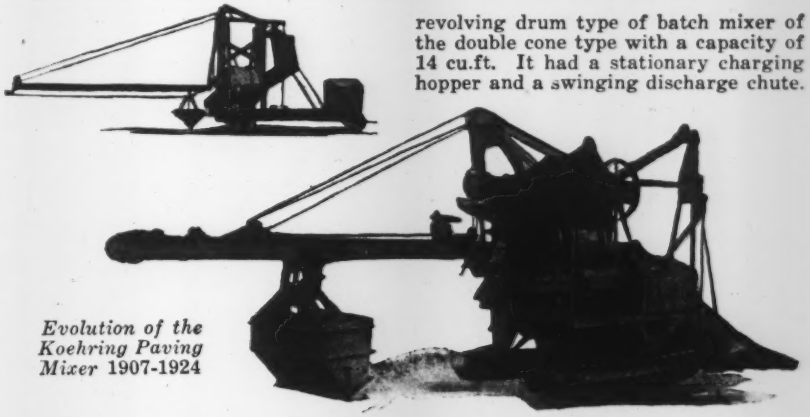
When Smith brought out his first mixer in 1900, the Ransome machine had not found an extensive use in the Middle West and practically all mixing of concrete was done by hand, with a



Koehring's First Power Loader Machine, 1907

few occasional installations of the continuous mixer. The first Smith mixer was sold to the Northwestern Tile Co. of Milwaukee and was followed by orders for five more. All of these machines were purchased under an agreement not to sell to any other concern in the city. This monopoly enabled the company to bid low and secure a large volume of work, but the demand for these mixers in Milwaukee soon reached the point where both parties to the original agreement recognized the futility of it and the contract was cancelled by mutual consent. The first Smith machine was the only one chain-driven; all others were equipped with

First Rex (Chain Belt Co.) Building Mixer. Sold in 1911



Evolution of the Koehring Paving Mixer 1907-1924

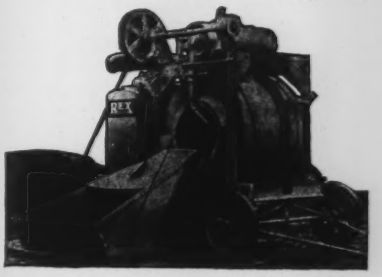
gear drive. Smith followed up his first mixer with many improved features, including a mechanical power tilting mechanism, non-pivoted extensible type of power loading skip, various improvements in water tanks, valves and discharge chutes. Later the company manufactured a non-tilting drum type of machine.

For a period of about ten years, beginning in 1898, designers produced a great variety of concrete mixers. Most of these operated on the revolving drum principle, but a new type, known as the Hains gravity mixer, consisted of a series of hoppers, one underneath the other. Concrete materials were introduced in the uppermost hopper and allowed to fall, successively, into the lower hoppers. For this method the chief advantage claimed was the elimination of power equipment, but on account of the tall vertical structure necessary to carry the hoppers it was necessary to hoist the material a considerable height to charge the upper hopper. This gravity mixer was manufactured commercially and was used on a number of large-scale projects, including dam construction. The gravity mixer, however, failed to meet the favor of many engineers who considered that its results were not as dependable as those obtainable with a rotating drum machine.

Continuous Mixer—Another chapter in the history of the concrete mixer is found in the records of the Foote Concrete Machinery Co. The first Foote mixer was built in 1896, and was a hand-operated machine of the continuous type, claimed to be the first continuous mixer of the automatic proportioning type placed on the market in the United States. It consisted of a stationary steel open trough 48 in. long and 24 in. in diameter equipped with 24 mixing blades revolving on a horizontal shaft, driven by a gasoline engine. The proportioning device consisted of two measuring hoppers, one for cement and the other for sand and gravel, this material being fed into the trough at predetermined rates by a revolving steel worm. These continuous machines were used largely for paving base, the first one being sold to the Barber Asphalt Co. In 1910, however, the city of Seattle prohibited the use of the continuous mixer; other cities followed the same practice and by 1915 their sale had practically stopped.

In 1907 the company brought out a revolving drum type of batch mixer of the double cone type with a capacity of 14 cu.ft. It had a stationary charging hopper and a swinging discharge chute. A power loading skip was added in 1908. Three years later a "high frame" model, designed for street paving work, was brought out. Other developments occurred, the most important of which was the equipment in 1918 of a paving mixer with full-length caterpillar type of traction.

Paving Mixer—Concrete mixers, in their early days, were used largely for building and general construction. With the beginning, fifteen years or so ago, of the great movement for paved roads which has since swept over the country, a new name, Koehring, appeared in the concrete mixer field. Incorporated in 1907, the Koehring Machine Co. produced its first concrete mixer the following year and in sixteen years grew to be the largest plant in the world devoted to the manufacture of concrete mixers. This first machine was of the non-tilting batch type and it



Modern 7-S Rex Machine on Rubber-Tired Wheels

is claimed to be the first mixer equipped with a successful power loader, then designated as an "automatic charging bucket," operated by a friction clutch and provided with an automatic stop. This machine, shown in one of the illustrations, was driven by an internal combustion engine through chain and sprocket and was supported on a frame-work of timbers which have given way in succeeding years to all-steel construction.

Philip Koehring, a decade and a half ago, visualized the result of the then incipient public demand for paved highways, and while producing mixers of the building type he devoted particular attention to devising a machine which would meet the particular needs of the road builder. To Koehring are credited many of the features of the modern "paver," now in its larger sizes a huge self-contained unit on full crawler trac-

tion with an output, for a standard machine, of as much as 32 cu.ft.

The early Koehring mixers had a drum which, in principle, has been retained up to today. Its features were two cast heads with the runway and gear cast integral with the head and with a heavy boiler plate shell tightly bolted and riveted to the two heads. In designing the drum all sharp corners were eliminated and stress was laid by the inventor on thorough mixing action and a type of discharge chute which aided the mixing process. The process was described as a three-fold remixing action in which the blades propelled the material into the mixing buckets; the buckets raised and dumped it on the discharge chute; the latter, in turn, caused the material to cascade in a showerlike spray. In adapting his mixer to paving work, Koehring, in the fall of 1907, equipped the machine, which was self-propelled, with a distributing boom and power-operated bucket, the first of their kind. The first paver built had a capacity of 24 cu.ft. of dry material, a size which proved too large at that time.

The year 1909 saw further developments in the paving mixer. Wood for the supporting frame had been discarded and steel and iron substituted. In 1912 the automatic dumping feature on the distributing bucket was first used and pavers appeared for the first time with traction having two speeds forward and one speed reverse. The company first applied its multi-plane traction in 1918.

Chain Drive

Various types of mechanism have been employed to rotate the drums of concrete mixers. In 1908 the Chain Belt Co., established in 1891, entered the mixing field with its first Rex building mixer of 10 cu.ft. capacity. Among its features was a steel bushed roller chain drive, the idea being to develop a flexible drive which would, to a large extent, diminish the force of shocks transmitted from the engine to the rest of the machine. This mixer also was equipped with a semi-steel drum mounted on bronze bushed rollers which revolved on the shaft instead of being keyed to it; this feature was designed to preserve the alignment of the drum. The same company built its first paver in 1912; it was a 10-cu.ft. machine chain-driven from engine to shaft, shaft to drum, and from engine to rear axle.

To speed the operation of concrete mixers designers have laid particular stress on the charging and discharging operations. On the modern Rex paver the charging skip is of the so-called stream-line form instead of the bottle neck shape originally employed. Coupled with a large throat opening, the stream-line skip empties its material into the drum in a minimum amount of time—10 sec. or thereabouts as compared with 30 sec. on the older models. On its paver, the company claims, inclosed transmissions were used for the first time and have proved highly successful.

Improved Blade—Reverting to the building type of mixer, an important development occurred in 1907, when A. W. Ransome, son of the pioneer mixer manufacturer, developed a form of mixing blade raised slightly from the interior surface of the drum to provide a "water clearance" for cleaning. This move put a quietus on competing manufacturers who were producing mixing drums without any blades whatever, making much of the point that "You don't have to pound our mixer to clean it."

Coincident with the work done by Ransome was that of F. C. Austin, of Chicago, who took the cumbersome cube mixer used in the early days by the U. S. Army engineers and, while preserving the cubical feature, converted it into a modern mechanically efficient device which could be charged or discharged while the drum rotated.

For the Panama Canal huge mixers with a capacity of 4 cu.yd. were built, but for the ordinary run of construction, especially as applied to buildings, a 1-yd. machine is about as large as is generally used. One of the most recent developments in the concrete mixer field is the agreement reached in joint conference by manufacturers and contractors on the following scale of standard sizes measured in cubic feet of mixed concrete: For building mixers, 28, 21, 14, 7, 5 and 3½ cu.ft.; for pavers, 21, 13 and 7 cu.ft.

(Next Article: The Hoisting Engine)

The Rock Drill

To the Editor, "Engineering News-Record:"

I have read with interest the article in your issue of April 24, p. 745, on "The Rock Drill." The McKiernan Drill Co., which was later succeeded by the McKiernan-Terry Drill Co., started in 1904 the manufacture of a rotating hammer drill, at that time called power hand-drills. These drills were sold to a number of contractors throughout the country and we believe them to be one of the earliest of the hammer drills of a rotating type that could be operated by one man without mounting. This same type of drill is still in use.

We do not claim, however, to be the first to develop a rotating hammer drill as there were a number of these drills built in foreign countries much earlier. For instance, we refer you to Low's British patent No. 1778 of July 5, 1865; Warsop and Hill's British patent No. 1181 of April 4, 1874; H. Haupt's American patent No. 46668 of March 7, 1865, in which he describes a rotating hammer drill. Also to Karl Franke's German patent No. 61736, Class 5, of April 6, 1892.

It would appear from these earlier patents that the inventors tried to reproduce mechanically the same action as occurred manually. Hence, first, the invention of the hammer drill; second, a machine for grasping the steel and throwing it against the rock to be drilled, imitating a churn drill; third, the connection of the steel and piston, as in Fowle's patent; and fourth, returning again to the first principles and using the hammer type of drill which has proved far more efficient than any other type.

T. E. Sturtevant,
Chief Engineer,
McKiernan-Terry Drill Co.

New York, April 25.

An American Alumina Cement Put on Market

The Atlas Aluminate Cement Co., 25 Broadway, New York City, announces the commercial production of an alumina cement, to be known as "Lumnite" cement, which is being manufactured under the Spackman patents at Northampton, Pa., in quantities to meet demand as it develops. The company has been studying this high-strength cement for some time and has been producing it experimentally for about nine months. It is now convinced of its ability to produce a uniform cement, which will pass the standard specifications for portland cement (with the occasional exception of the insoluble residue provison) and which will consistently test for the 24-hr. period a compressive strength higher than that reached by portland in 28 days. Because of the requirements of manufacture and the difficulty of getting the alumina ore (which has in this case been imported from Dalmatia) the price of the cement is about three times that of portland at the mill; the exact ratio of price varies with the freight charges.

Alumina cement (see *Engineering News-Record*, Aug. 30, 1923, p. 347) is a high-alumina hydraulic cement, perfected in France during the war, but covered by early U. S. patents to Henry S. Spackman. Its outstanding quality is its early high strength, which makes it particularly valuable in all kinds of concrete work where early use of the structure is desirable or economical. It is also claimed to be especially resistant to saline waters.

Business Notes

Good Roads Machinery Co., Kennett Square, Pa., has opened a warehouse at 49th and Halsted Sts., Chicago, where there will be carried a complete stock of road-building machinery and parts. The warehouse will be equipped for the quick shipment of repair parts. The company's Chicago office will be moved to the new warehouse.

Griscom-Russell Co., New York, manufacturer of the Jiffy dump-body for trucks, announces the appointment of the following four new distributors: Carolina Body Co., Greensboro, N. C.; Field Corporation, Chicago Branch; N. B. Schuster Co., St. Louis; and the Watkins Commercial Body Co., Cincinnati. The company now has a total of 23 distributors throughout the United States.

National Slag Association, Cleveland, held its seventh annual meeting at the Bureau of Standards and the Bureau of Public Works in Washington, D. C., March 28 and 29. The following officers were elected: President, C. L. McKenzie, Duquesne Slag Products Co., Pittsburgh; vice-president, C. E. Ireland, Birmingham Slag Co., Birmingham, Ala.; secretary-treasurer, H. J. Love, Cleveland.

PARADON ENGINEERING CO., Long Island City, N. Y., has been organized to manufacture chlorine control apparatus for all purposes, including water and sewage purification. The organizers are Richard V. Donnelly, who has resigned as manager of sanitary sales for the Wallace & Tiernan Co.; Howard Pardee, formerly assistant production manager for the same company, and S. Pincus, for seven and a half years sanitary engineer with the U. S. Public Health Service.

INDUSTRIAL WORKS, Bay City, Mich., has just received an order from the Fort Pitt Bridge Works, Pittsburgh, for a 35-ton locomotive crane. The machine will have double automatic independent hoisting drums and a 50-ft. basic boom with inserts for working at 70, 90 and 110 ft.

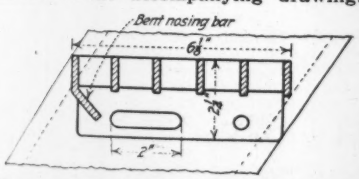
PENNSYLVANIA PUMP & COMPRESSOR CO., Easton, Pa., has appointed the Pneumatic Equipment Co., headed by George S. Githins, as district representative for New England, with offices at 110 High St., Boston, Mass. The products of the company are air compressors of the stationary and portable types, centrifugal, double-suction, single stage and multistage pumps and a portable pumping unit on wheel mounting.

E. GEORGE & CO., equipment distributors, have moved from 407-9 Broadway, New York, into larger quarters in a building purchased by the company at 483-87 Broome St., New York. The new quarters will serve as a New York warehouse, office and service station, in addition to which the company's Brooklyn warehouse and shop will continue in operation.

Equipment and Materials

Open Grating Stairway Has Edge of Tread Marked

To increase the visibility of the edges of the treads on stairways of the open grating type and thus prevent accidents from slipping and falling, the Mitchell-Tappen Co., New York, has introduced a new feature in the form of a nosing bar bent to an angle of 45 deg., as shown in the accompanying drawing.

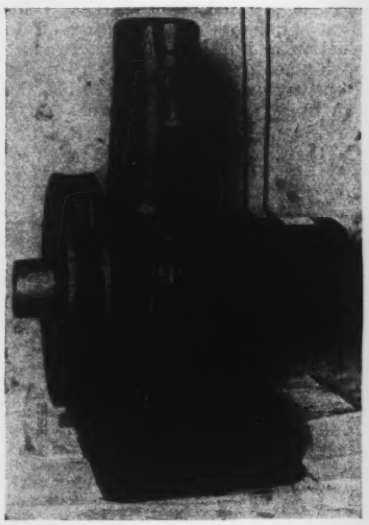


To a person descending the stairway, this bent bar clearly defines the edges of successive treads, thus eliminating the necessity of painting white bands at these points. The latter practice has been followed by some companies, but the device is only temporary as the paint wears off.

The bent nosing bar, while producing the appearance of a solid line, does not clog the openings in the treads and sheds both dirt and water. The new tread, the company believes, will remove objections to this type of stair way on the score of dizziness and the possibility of accident, especially in the case of men descending the stairways while carrying crates, machinery parts or other heavy loads.

Small Light and Power Plant for Use Without Battery

A small light and power plant for use without a battery has been developed by the Westinghouse Electric & Manufacturing Co., East Pittsburgh, Pa., for service wherever the current can be turned directly into the line at such places as oil and gas wells, quarries, construction camps, lumber camps, pumping stations, brick yards, barges, and dredges. The plant has a capacity of 1,500 watts at 110 v. and operates on kerosene or natural gas. It consists of a single-cylinder, four-cycle gasoline engine and a 1,500-watt, four-pole generator built into a single compact unit. The engine is air-cooled, which makes it possible to install it in unheated places, operates at a slow

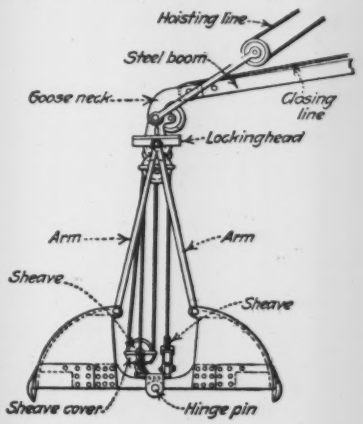


speed, and has a capacity of sixty 25-watt lamps or about 1½ hp. A distinctive feature of the plant, the manufacturer claims, is its ease and simplicity of operation. There are no complicated adjustments or operations necessary for starting or stopping and no other attention is necessary while it is running except to keep the fuel and oil tanks supplied.

A fan in the flywheel draws air into the cylinder dome and over the cylinder fins, assuring cool operation under all conditions. The engine is lubricated by a splash feed system which supplies an equal amount of oil to the moving parts at all times regardless of the depth in the crankcase. This is accomplished by an oil carrying gear that dips into the oil in the crankcase and carries it to a pan, keeping the oil in this pan at a constant level. A simple Venturi mixing valve is used instead of the usual carbureter. Fuel is drawn by suction to this valve from the 6-gal. tank built into the base of the unit.

Excavating Bucket Has Rotating Head Attachment

Designed as a trenching tool for digging in hard materials, the bucket developed by Fogarty Excavating Appliances, Inc., Rochester, N. Y., is similar to the clamshell except that instead of being suspended by wire rope and free to swing, it is fastened by a rotating head to the end of a steel operating arm set in a boom socket. The closing line runs over the end of this arm to the closing sheaves and, according to the claims of the manufacturer, all the



power increased by four or five reevings is back of the "bite" of the bucket without any closing line lift.

The bucket is built in four sizes—½, ¾, 1 and 1½ yd.—and weighs from 4,600 to 7,100 lb. It can be attached to any standard two-drum crane, convertible shovel or A-frame traveler, with the operating arm built to the length suitable to the balance and capacity of the machine. With the operating arm and rotating head features, the digging of the bucket can be closely controlled. A patented swivel head permits the bucket to turn while hanging free, but locks rigidly when the bucket is in contact with material to be excavated. The operating arm holds the bucket into the material being dug. The bucket may be converted into an ordinary clamshell by removing the swivel head and substituting a line head containing four small sheaves. Ordinarily the length of the operating arm is 30 ft.

Publications from the Construction Industry

Insulating Fabrics — Westinghouse Electric & Manufacturing Co. has published a new booklet, dealing with fabrics and papers for insulating purposes. All the forms of treated and untreated fabrics, tapers, sleeving, tapes, cord and thread manufactured by the company are described in the booklet and their principal applications given. For the purpose of easy reference, tables have been included setting forth in tabulated form the thickness, width, approximate weight, and size of the various materials described.

Business Side of Construction

FACTS AND EVENTS THAT AFFECT COST AND VOLUME

Production of Iron, Steel, Lumber and Brick Slower During April

Cement and Lumber Output for First Quarter Considerably Heavier Than for Same Period in 1923

Iron and Steel—Pig-iron production, measured by the number of furnaces in operation, declined about 17 per cent in the Pittsburgh and nearby districts during April. The April steel ingot output fell off about 20 per cent from the preceding month. The March total was 3,953,048 tons, according to the American Iron and Steel Institute, therefore the estimated output for April would be about 3,162,400 tons. The present rate of mill operations is about 70 per cent of capacity.

Brick—Reports from the Common Brick Manufacturers' Association of America, dated May 1, show an increase of more than 26 per cent in orders on books. There are fewer burned brick on hand and a greater quantity of newly made brick not yet burned; a considerable increase is noted in the quantity moved from yards throughout the country. While there is an unusually heavy demand for brick in both New York and Chicago, there is danger of scarcity only at the extreme peak of the building season. The current situation compared with a month ago and one year ago, is shown in the following table:

	Burned Brick on Hand M	Unburned Brick on Hand M	Brick Moved from Yards During Month M	Orders on Books M
1923				
Apr. 1	181,298	44,940	.....	463,752
1924				
Jan. 1	313,696	55,646	66,199	266,914
Feb. 1	306,503	38,349	45,762	272,403
Mar. 1	282,813	39,695	104,663	263,219
Apr. 1	250,118	46,226	142,197	335,926

Lumber—The lumber movement for the entire country, according to reports of the National Lumber Manufacturers' Association, dated May 1, shows increased shipments and a falling off in production and new business. Production, shipments and orders are all under the corresponding week in 1923, as shown by the following figures:

	Production	Shipments	Orders
1924	3,913,760,123	3,935,576,130	3,784,077,504
1923	3,754,477,293	4,214,780,838	4,199,150,789
1924 increase	159,282,830	.....	.....
1924 decrease	.....	279,204,708	415,073,285

The following table compares the national lumber movement for the first seventeen weeks of 1924 with the corresponding period last year:

	Past Week Ft. b.m.	Corresponding Week in 1923 Ft. b.m.	Preceding Week in 1924 Ft. b.m.
Production	244,132,293	247,405,915	245,800,453
Shipments	246,254,701	247,312,756	235,326,874
Orders	205,312,003	225,990,250	213,128,707

Cement—There were 27,746,000 bbl. produced during the first quarter of 1924 as against 26,080,000, for the corresponding period last year. First quarter shipments amounted to 20,138,000 bbl. this year, compared with 22,044,000 in 1923. Mill stocks on hand April 1, totaled 18,190,000 bbl., against 13,045,000, one month ago and 16,815,000, one year ago. The cement situation is one of increased production and reserve stocks and falling off in demand, as shown by the following table:

1923	Production (Barrels)	Shipments (Barrels)	Stocks on Hand at End of Month (Barrels)
January	7,990,000	5,628,000	11,477,000
February	8,210,000	6,090,000	13,596,000
March	9,880,000	10,326,000	13,045,000
April	11,359,000	12,954,000	11,463,000
May	12,910,000	14,257,000	10,144,000
June	12,382,000	13,307,000	9,168,000
July	12,620,000	13,712,000	8,081,000
August	12,967,000	14,971,000	6,080,000
September	13,109,000	13,698,000	5,533,000
October	13,350,000	14,285,000	4,612,000
November	12,603,000	10,251,000	6,991,000
December	9,997,000	6,408,000	10,575,000
Total	137,377,000	135,887,000	.....
1924			
January	8,788,000	5,210,000	14,153,000
February	8,588,000	5,933,000	16,811,000
March	10,370,000	8,995,000	18,190,000

CONDITIONS OF MATERIALS STOCKS IN IMPORTANT CENTERS

Stocks on hand in approximate figures, example: (Common brick, Denver, 1,000,000); time required for delivery of carload lots to city job, example: (Hollow tile, Atlanta, deliveries take 4 @ 5 days); and stocks on hand in general terms, example: (Sewer pipe, Cincinnati, plenty, all sizes).

	San Francisco	Los Angeles	Denver	Minneapolis	Detroit	Cincinnati	New Orleans	Atlanta	Philadelphia	New York
Sewer pipe	Stocks in usual good condition	Supply keeping up with demand	Still slight shortage	Adequate	Moderate supply in local yards	Plenty all sizes	Stocks in fair shape	Del. take 4 to 5 days	Adequate	Dealers' stocks usually small; mill del. prompt.
Cement	Fairly well supplied	Plenty	Enough	Plenty in local warehouses	Abundant stocks at nearby mills	Readily obtainable	Plentiful	About 75 cars on sidings	Stocks in good shape	More on hand than month ago or year ago.
Lime	Stocks in fair shape	Steady demand being met	Sufficient	No trouble in filling orders	Plenty available	Adequate supplies	Normal as to supply and demand	From 60 to 70 cars	Ample	Dealer's stocks usually small; mill del; prompt.
Common brick	Dealers' stocks in good shape	Well supplied	1,000,000	Readily obtainable from nearby sources	Ample in local yards	Plentiful	Stocks low	Plentiful	Sufficient for demand	No shortage; some German and Belgian brick received
Hollow tile	Supply always good	Meeting demand	Stocks replenished	Del. on short notice from nearby plants	Large del. require several days	No trouble in filling orders	Supply good	Del. take 4 to 5 days	Coming in as needed	Dealers' stocks usually small; prompt mill del. by rail and water.
Lumber	Very large reserves	Large quantities available	Normal	Yard stocks normal for season	10,000,000 ft. b.m., normal	Adequate stocks in dealers' yards	Yel. pine stocks normal	Plentiful	Yards well stocked	Stocks larger; output increased; demand slower.
Asphalt	Large native reserves	Supplied as needed	Sufficient	Ample	.....	Plenty	.....	From 50 to 60 cars	Enough to cover demand	Heavy reserves in N. J.
Structural steel	Ample supply of shapes, plates and bars	Warehouse supplies keeping up with demand	Warehouses well stocked	Enough in warehouses	Normal warehouse stocks	Demand more active in warehouses	.....	From 4 to 5 cars	Small warehouse stocks carried; del. prompt	Warehouse demand more active owning to slowing down of mill operations.

Unit Prices on Accepted Federal-Aid Road Bids

An idea of the cost of various materials and operations in public road construction throughout the country, may be gained from a study of the two accompanying tables.

The figures are from the Bureau of Public Roads, U. S. Department of Agriculture and involve average accepted bids on Federal-aid highway projects during February, 1924.

Prices are given for items and materials furnished in place on the project. Gravel bids are listed by square or cubic yard, depending upon the specifications of the various states.

Structural concrete, Classes A and B in New York State and Classes A and C in Tennessee (Table I) contain state furnished cement and bitumen, prices of which are not included in the total cost of the item. The same rule applies to reinforced cement concrete in New York State, as shown in Table II.

No bids are listed for the New England states. The western portion of the North Central States furnished the greatest number of bids of all the geographical divisions.

Link-Belt Executive Sees Good Business Ahead

Charles Piez, president of the Link Belt Co., with plants in Chicago, Philadelphia, Indianapolis and on the Pacific Coast, and offices in the principal industrial centers, said in an interview with a representative of this paper:

"Our plants as a whole are running at 85 per cent of their normal 48-hour week capacity. The Philadelphia plant in January, February and March did not show up so well, but there has been a large increase in orders and production in April and we look for a continued upward trend in the Eastern territory. For the Middle Western plants business has been brisk and the same applies, but in increasing measure, for the West Coast plant and office.

"Assurance of legislation still further restricting immigration makes materials-handling by machinery necessarily a growing business. Foundries and the coal mines, in particular, are now buying in increasingly large volume.

"Such hesitation as exists on the part of buyers is due, so the buyers themselves state, to the disturbance of the forthcoming election and the Washington political situation. Financial and business conditions of the country generally, however, are sound and stable."

First Quarter Building Slower Than Year Ago

Industrial Building Slowest, But Residential Contracts in New York Greatest Ever

A general survey of construction for the first quarter and especially March of this year brings out the following facts:

Industrial building (awards of $40,000 and over) started the year well but the total of awards dropped in each succeeding month. The totals for the United States are: January, $30,944,000; February, $24,167,000; March, $12,602,000. March, 1923, awards aggregated $22,917,600.

Commercial building for the first quarter also shows a monthly decline which is in direct contrast to the gain of each month for the same period in 1923. Awards of $88,552,000 in January dropped to $79,519,000 for March this year. Other construction awards exclusive of buildings for March, 1924, are under those of March, 1923. The totals are $74,114,000 and $96,489,600, respectively. The first quarter of 1924 totaled $157,904,000, compared with $203,236,000 a year ago.

Residential building exclusive of New York City is 5 per cent under a year ago, according to the F. W. Dodge Co. The building situation in New York, however, has reached a new peak—103 per cent over the record year, 1923. The chart shows that the value of residential contracts in New York was actually greater than for the rest of the country (36 states) covered.

Business in general is slower than a year ago. Debits to individual accounts were one billion dollars less in March than a year ago—a drop of 2.4 per cent.

The steel and iron industries during the first two months of the year showed an expansion in consumption and production, but experienced a gradual de-

TABLE II—AVERAGE ACCEPTED BID PRICES OF SURFACING AND STEEL ON FEDERAL AID PROJECTS

Geographic Divisions and States	Surfacing: Gravel Sq.Yd.	Gravel Rate	Bit. Mac. Sq.Yd.	Bit. Mac. Rate	Plain Cem. Conc. Sq.Yd.	Plain Cem. Conc. Rate	Reinf. Cem. Conc. Sq.Yd.	Reinf. Cem. Conc. Rate	Steel: Reinforcing Lb.	Reinforcing Rate	Structural Lb.	Structural Rate
Totals for U. S.	1,264,240	$0.32	179,784	$1.82	238,457	$2.23	279,821	$1.91	2,786,006	$0.05	417,735	$0.09
Middle Atlantic	97,200	.39	2,869	1.19			164,604	1.57	614,800	.04	65,775	.10
New York	97,200	.39	2,869	1.19			164,604	1.57	614,800	.04	65,775	.10
E. No. Central			33,207	2.32			28,843	2.55	46,100	.05		
Ohio			33,207	2.32			28,843	2.55	46,100	.05		
W. No. Central	904,926	.20					63,865	2.40	404,176	.06	167,960	.08
Iowa							61,289	2.38				
Missouri	52,800	.42							279,124	.06	164,208	.08
Nebraska	852,126	.19					2,576	2.60	28,462	.05	3,752	.10
Kansas									96,590	.06		
South Atlantic					572	2.00			91,243	.06		
W. Virginia									12,650	.07		
Georgia					572	2.00			78,593	.06		
E. So. Central			143,708	1.72	152,125	2.15			1,098,775	.05		
Tennessee			143,708	1.72	152,125	2.15			1,077,626	.05		
Mississippi									21,149	.06		
W. So. Central							22,509	2.55	404,272	.06		
Louisiana									27,426	.06		
Texas							22,509	2.55	376,846	.06		
Mountain	83,650	.46			85,760	2.36			72,140	.08	184,000	.10
Colorado	83,650	.46			85,760	2.36			72,140	.08	184,000	.10
Pacific	178,464	.78							54,500	.08		
Oregon	178,464	.78										
California									54,500	.08		

TABLE I—AVERAGE ACCEPTED BID PRICES OF MATERIALS, EXCAVATION AND STRUCTURAL CONCRETE ON FEDERAL AID PROJECTS

Geographic Divisions and States	Excavation: Common Cu.Yd.	Common Rate	Unclassified Cu.Yd.	Unclassified Rate	Rock Cu.Yd.	Rock Rate	Materials: Gravel Cu.Yd.	Gravel Rate	Sand Clay Cu.Yd.	Sand Clay Rate	Crushed Stone Cu.Yd.	Crushed Stone Rate	Structural Concrete: Class A Cu.Yd.	Class A Rate	Class B Cu.Yd.	Class B Rate	Class C Cu.Yd.	Class C Rate	State Furnished Material: Cement Bbl.	Cement Rate
Totals for U.S.	2,242,888	$0.38	427,599	$0.68	211,447	$1.26	126,629	$1.64	51,029	$1.16	70,383	$2.97	17,642	$19.00	4,975	$16.40	1,074	$20.60	124,118	$2.46
Middle Atlantic	119,175	.93	198,000	.80	7,450	2.58							3,215	9.84	860	7.90			68,618	3.08
New York	119,175	.93	198,000	.80	7,450	2.58							3,215	9.84	860	7.90			68,618	3.08
E. North Central			41,825	.63							50	3.00	426	20.10	308	16.90	234	13.10		
Ohio			41,825	.63							50	3.00	426	20.10	308	16.90	234	13.10		
W. No. Central	979,617	.29	3,034	.69	14,506	1.59			19,184	1.79			1,018	18.50	2,157	17.00	123	17.20		
Iowa	51,882	.47																		
Missouri	341,050	.32	3,034	.69	13,956	1.57							251	19.10	2,157	17.00	123	17.20		
Nebraska	585,905	.25			500	1.60														
Kansas	780	1.16			50	5.50			19,184	1.79			767	18.30						
South Atlantic	126,629	.30	90,300	.55	8,086	.94	27,840	4.75	21,748	.39	333	3.00	711	22.10	899	17.70				
West Virginia			90,300	.55									139	19.00	770	17.00				
Georgia	126,629	.30			8,086	.94	27,840	4.75	21,748	.39	333	3.00	572	22.90	129	21.80				
E. So. Central	448,350	.46			37,591	1.74							7,050	22.50	560	22.40	304	28.50	55,500	1.70
Tennessee	345,595	.51			37,591	1.74							6,856	22.30	560	22.40	277	28.70	55,500	1.70
Mississippi	102,755	.29											194	28.40			27	27.00		
W. So. Central	180,017	.23			45,214	.45	97,979	.76	10,097	1.63			4,111	18.30	53	20.80	43	21.80		
Louisiana	21,673	.35					20,289	2.14	10,097	1.63			301	22.00			40	22.00		
Texas	158,344	.22			45,214	.45	77,690	.40					3,810	18.00	53	20.80	3	19.00		
Mountain	132,100	.51			82,900	1.22	810	1.50					711	23.90	138	22.30				
Wyoming	46,000	.50			43,000	1.65														
Colorado	86,100	.52			39,900	.85	810	1.50					711	23.90	138	22.30				
Pacific	257,000	.38	94,440	.57	15,700	1.60					70,000	2.97	400	23.50			370	19.50		
Oregon	257,000	.38			15,700	1.60					42,500	2.56								
California			94,440	.57							27,500	3.60	400	23.50			370	19.50		

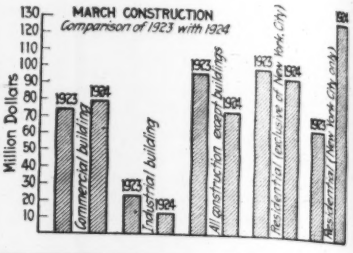
cline in both throughout March. The end of March, according to the report of the United States Steel Corporation, marked a slump of over 130,000 tons of unfilled orders. The first quarter of 1922 and 1923 registered a gain of 119,343 and 353,079 tons, respectively.

Prices of non-ferrous metals started downward in March, due to lessening demand, and are now under those of a year ago. Nearly all the other commodities have weakened, but building materials prices are still well above those of last year, while labor rates continue to rise.

The following table shows the comparative standing of construction and certain other business factors for March, 1924 and 1923. The figures for the bank and business failures are R. G. Dun & Co.'s:

	March 1924	March 1923
Commercial Building	$79,519,000	$74,428,000
Industrial Building	12,602,000	22,917,600
Residential Building	95,000,000	100,000,000
New York Residential Building	132,000,000	64,000,000
All construction, exclusive of buildings	74,000,000	96,800,000
Unfilled Steel Tonnage	4,782,807	7,403,332
Car Loadings	907,548	936,374
	No. Liabilities	No. Liabilities
Business failures	1817 $97,651,026	1682 $48,393,138
Bank failures (1st quarter)	265 100,275,600	65 12,052,000

The chart compares March, 1924 and 1923 as to building construction. The residential contracts are F. W. Dodge figures, all other construction awards are drawn from *Engineering News-Record* statistics.



Weekly Construction Market

THIS limited price list is published weekly for the purpose of giving current prices on the principal construction materials, and of noting important price changes on the less important materials. Moreover, only the chief cities are quoted.

Valuable suggestions on costs of work can be had by noting actual biddings as reported in our Construction News section.

The first issue of each month carries complete quotations for all construction materials and for the important cities. The last complete list will be found in the issue of May 1, the next, on June 5.

	New York	Atlanta	Dallas	Chicago	Minneapolis	Denver	San Francisco	Seattle	Montreal
Steel Products:									
Structural shapes, 100 lb.	$3.59	$3.75	$4.40	$3.30	$3.55	$4.20	$3.60	$3.60	$4.20
Structural rivets, 100 lb.	4.40	4.50	4.90	3.75	4.00	5.15	5.00	4.25	5.00
Reinforcing bars, ¾ in. up, 100 lb.	3.49	3.25	3.38	3.20	3.45	3.85	3.65	3.50	3.90
Steel pipe, black, 2½ to 6 in. lap, discount	44%	—54.2%	43%	47%	55.05%	36%	36.80@49.10%	45%	47.43
Cast-iron pipe, 6 in. and over, ton	61.60@63.60	+55.00	61.00	57.20@60.20	—60.50	69.00	60.00	65.00	60.00
Concreting Material:									
Cement without bags, bbl.	2.50@2.60	2.35	2.05	2.20	2.42	2.84	2.61	2.90	2.72
Gravel, ¾ in., cu.yd.	—1.75	2.00	2.38	2.00	1.85	1.90	2.15	1.50	1.50
Sand, cu.yd.	1.25	1.40	2.00	2.00	1.25@1.50	1.00	1.50	1.50	1.25
Crushed stone, ¾ in., cu.yd.	1.85	2.00	2.83	2.00	2.00	3.50	2.15	3.00	1.90
Miscellaneous:									
Pine, 3x12 to 12x12, 20 ft. and under, M.ft.	63.00	40.00	60.22	—53.50	41.75@43.00	49@53	36.00	—27.00	65.00
Lime, finishing, hydrated, ton	18.20	22.50	20.00	20.00	25.50	24.00	+22.60	24.00	21.00
Lime common, lump, per bbl.	3.00@3.25	1.65	1.85	1.50	1.40	2.70	2.10	2.80	+10.50
Common brick, delivered, 1,000	23.65	12.00	14.10	11.00	15.00	12.00	15.50	15.00	17.50
Hollow building tile, 4x12x12, per block	Not used	.09½	.11	.064	.075	.075	.....	.11	.12
Hollow partition tile 4x12x12, per block	—.1162	.09½	.11	.....	.....	.075	.108	.11	.....
Linseed oil, raw, 5 bbl. lots, gal.	.95	+1.00	—1.09	.94	1.06	—1.11	1.05	—1.13	+1.21
Common Labor:									
Common labor, union, hour	.75	.30	.....	.....	.....	.50@.55	.55	.62½	.....
Common labor, non-union, hour	....	.25	.30@.50	.82½	.50@.55	.35@.50	50	.62½	.25

Explanation of Prices—Prices are to contractors in carload lots unless other quantities are specified. Increases or decreases from previous quotations are indicated by + or — signs. For steel pipe, the prevailing discount from list price is given; 45-5% means a discount of 45 and 5 per cent.

New York quotations delivered, except sand, gravel and crushed stone, alongside dock; common lump lime, in 280-lb. bbl. net, and hydrated lime f.o.b. cars; tile "on trucks"; linseed oil and cast-iron pipe f.o.b.

Labor—Concrete laborers' rate, 93¾c.; building laborers (pick and shovel men) 75c. per hr.

Chicago quotes hydrated lime in 50-lb. bags; common lump lime per 180-lb. net. Lumber delivered on job.

Minneapolis quotes on fir instead of pine. Brick, sand and hollow tile delivered. Cement on cars. Gravel and crushed stone quoted at pit. We quote on brown lime per 180-lb. net; white is $1.80 for Kelly Island and $1.70 for Sheboygan. Common labor not organized.

Denver quotes on fir instead of pine. Cement "on tracks"; gravel and sand at pit; stone on cars; lime, brick, hollow tile and lumber on job. Tile price is at warehouse. Linseed oil, delivered, in iron bbl. Common lump lime per 180-lb. net.

Atlanta quotes sand, stone and gravel per ton instead of cu.yd. Common lump lime per 180-lb. net.

Dallas quotes lime per 180-lb. bbl. Steel, cement, cast-iron pipe and crushed stone f.o.b. cars, other materials delivered.

San Francisco quotes on Heath tile, size 5½ x 8 x 11½. Prices are all f.o.b. warehouses except C. I. pipe, which is mill price plus freight to railway depot at any terminal. Common lump lime per 180-lb. net. Lumber prices are to dealers in yards at San Francisco, for No. 1 fir, common.

Seattle quotes on Douglas fir (delivered) instead of pine. Lump finishing lime per 180-lb. net. Hollow building tile delivered. Hydrated lime in paper sacks. Sand and gravel at bunkers.

Montreal quotes on Douglas fir instead of pine. Sand, stone, gravel and lump lime per ton. Cement, lime and tile are delivered; sand, gravel and stone on siding; brick f.o.b. plant; steel and pipe at warehouse. Hollow tile per ft. Cement price is in Canadian funds (the Canadian dollar stands at 98.40). Bag charge is 80c. per bbl. Discount of 10c. per bbl. for payment within 20 days from date of shipment. Steel pipe per 100 ft. net; 3-in., $47.43; 6-in. $119.

Weekly Review of the Market

Price declines predominate in the current building materials' market, according to correspondents in the various cities reporting weekly to *Engineering News-Record*.

The decidedly downward trend is due to contraction of demand brought on by a combination of causes. Chief among these causes are: (1) Uncertainty regarding pending tax legislation; (2) expectations of further lowering of prices and (3) unusually prompt mill deliveries, which induce the buyers to purchase for immediate needs only and not for replenishment of stocks.

The important declines during the last two weeks have affected the following basic materials: steel pipe; gravel; lumber (pine and fir); lime; hollow tile and linseed oil.

Restricted demand and receding prices are reflected in the present widespread curtailment of production. The downward trend in prices of materials is offset by the rising cost of labor. While building and a few other industries report wage advances, there have been reductions in other fields during the last month.

In New York City the structural iron workers went on strike May 1, for $12 per day as against the present rate of $10.50. Closed shop conditions were also demanded of the employers who have always been strongly inclined toward open shop principles.